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# FULL PAPERS

## ELEPHANT CONTRACEPTION RESEARCH IN THE KRUGER NATIONAL PARK

Ian J Whyte and Dave G Grobler

South African National Parks, Private Bag X402, Skukuza 1350, Republic of South Africa

### ABSTRACT

Two methods for contraception in elephants have received research attention in the Kruger National Park (KNP) over the past 12 months. These are "immuno-contraception" which uses porcine zona pellucida immuno-contraceptive vaccine (PZP), and hormonal control using subcutaneous oestradiol-17 $\beta$  (oestrogen) implants.

The immunocontraception technique has been demonstrated to be effective in other locations, but after 12 months, some of the treated cows were pregnant. Further research is needed to determine the reasons for some of the treated cows returning to breeding condition.

The oestradiol implants proved successful in the KNP as a contraception technique as none of the treated cows was pregnant after six months (at the end of the expected life of the implant). Even after 12 months none were pregnant, which may have been due either to sufficient amounts of oestrogen still being released by the implants preventing ovulation or a more permanent effect on the ovaries.

However, elephant cows treated with oestradiol-17 $\beta$  showed behavioural aberrances which probably resulted in substantially increased stress levels on the treated cows and their calves. Although behavioural abnormalities ceased approximately six months after implantation, the project was suspended (pending submission of another proposal by the research team) as it was considered unacceptable on both humane and ethical grounds.

### RESUME

Deux méthodes de contraception des éléphants ont préoccupé la recherche au PNK pendant les 12 derniers mois. Ce sont, "l'immuno-contraception" utilisant le vaccin (PZP) immuno-contraceptif à base de la porcine zona pellucida, et le contrôle hormonal utilisant l'oestradiol - 17 $\beta$  (oestrogen) sous-cutané.

La technique immuno-contraceptive a été employée, mais 12 mois après, 40% des femelles traitées étaient en gestation. D'autres recherches sont nécessaires pour déterminer les raisons pour lesquelles les femelles traitées sont retournées dans des conditions leur permettant de se reproduire.

L'implantation de l'oestradiol comme moyen de contraception a eu du succès. Sur 10 femelles traitées, aucune n'était à mesure de produire après six mois (jusqu'à la fin de la durée de vie de l'implantation). Même après 12 mois, aucune femelle n'a présenté des signes de gestation, ce qui explique qu'une quantité suffisante d'oestrogen apportée par l'implantation empêche l'ovulation ou a des effets permanents sur les ovaires.

Cependant, on a pu noter que les éléphants femelles soumis à l'oestradiol - 17 $\beta$  présentaient un certain comportement de stress. Bien que cette anomalie cessait six mois après l'implantation, le projet a été suspendu (identification d'une autre proposition de projet par l'équipe de recherche) car il était considéré inacceptable à la fois pour des raisons humains et éthiques. Ces animaux seront semestriellement examinés pour déterminer si et quand ils pourront retrouver les conditions normales de reproduction.

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## INTRODUCTION

Since 1967, when the culling of elephants was initiated in the Kruger National Park (KNP), many South Africans came to accept the policy and the reasons proposed by earlier managers for its necessity. But this policy has not been without controversy, and in late 1994 the issue was again raised when certain animal rights groups challenged the rationale for culling and the ethical morality of killing elephants. This challenge resulted in the holding of a public debate on the issue in May 1995, at which the South African National Parks (SANP) agreed to review the elephant management policy of the KNP. This review is almost complete (Whyte *et al.*, 1997). One of the principles accepted is that wherever possible, management of the South African elephant population will be conducted by non-lethal means (translocation and/or contraception). However, where neither of these options is possible, culling is the only remaining option available and will be used.

In accordance with this principle, SANP is supporting research on contraception. Two methods have received research attention in the KNP over the past 12 months. The first is the "immunocontraception" method and the other uses hormonal control through subcutaneously inserted oestradiol (oestrogen) implants. The status of contraception technology is not yet at a level where it can be used as a measure to control elephant populations (Whyte, van Aarde and Pimm, In press). By supporting this research, SANP hopes that it may lead ultimately to an ethically acceptable method to all parties, which is logistically feasible on a large elephant population in an area the size of KNP.

It is not the intention of this paper to report on the research findings of the two research groups. Any of their results mentioned here have previously been publicised in media releases. We have tried to put the issue in perspective from a SANP point of view only, and to report on behavioural data collected by SANP staff.

## IMMUNOCONTRACEPTION

The originators of the immunocontraception project are the Science and Conservation Biology Program, Montana; Faculty of Veterinary Medicine, Pretoria University; and the Humane Society of the USA.

Immunocontraception uses porcine zona pellucida immuno-contraceptive vaccine (PZP) to stimulate the target animal's immune system to prevent sperm penetration of the ovum (Kirkpatrick *et al.*, Undated). A sample of 21 adult elephant cows was given an initial inoculation of PZP vaccine at the time of

immobilisation, followed by a second inoculation given three to five weeks later. In two of these, collars malfunctioned leaving a research sample of 19 animals. This treatment was not expected to induce behavioural side effects as the hormone system of the target animal is not affected. No adverse side effects have been recorded and this project is continuing.

## OESTRADIOL - 17 $\beta$ IMPLANTS

The originators of the oestradiol-17 $\beta$  implant project are the Institute for Zoo and Wildlife Research in Berlin.

A second sample of ten adult cows was treated with an anti-ovulatory "negative feedback" application of oestradiol-17 $\beta$ . These cows each received five slow-release oestradiol-17 $\beta$  implants, inserted subcutaneously behind the ear in the neck area (Meyer *et al.*, Undated).

After six months, oestrogen levels were expected to decline and the cows were to receive a second implant. This second phase was not implemented and the project has been temporarily suspended by SANP due to behavioural aberrances which were induced by the high levels of oestrogen. These are discussed later in this report. The project may be reinstated on receipt of a new proposal with revised and improved protocols.

## CONCERNS WITH REGARD TO THE POTENTIAL NEGATIVE EFFECTS OF THE RESPECTIVE PROJECTS

Both of these projects had certain potential associated problems which were either addressed in the project protocols or were expressed by members of SANP's Department of Scientific Services (DSS) at the time the projects were initiated. These could take the form of social disruption, threats to the health and welfare of the treated animals and/or their calves, or behavioural aberrations. These are described below.

### Immunocontraception

There is some concern over a possible permanent effect on the cows' ovaries which may cause permanent sterility, as has been the case in dogs and rabbits. Research will be directed to determining if this occurs in elephants or not. Mating in elephants is a dramatic affair in which the cow is chased by the bull. This chasing can be extensive, with a certain amount of disturbance to other members of the family unit, and ends when the bull catches up to the cow and lays his trunk along her back. At this point (if she is ready to mate) she will stand and allow the bull to mate with her. If she is not ready to mate, she will try to prevent him from mounting and the chasing continues

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until she becomes receptive. Normally an adult cow would come into oestrus and be mated and conceive, and this would not be repeated until her next oestrus period after her calf was born. This would happen about once in four years. In the case of the immunocontraception, the cow will mate normally but will not conceive, and will then "cycle" and return to oestrus in about 15 weeks. The frequency of mating and its accompanying disturbances would be far more frequent, and the possible effects are not known, though negative social or behavioural effects are not expected.

## Oestradiol implants

Oestrogen is a known carcinogen in humans and monkeys when used in the dosages required to prevent conceptions. No information is available on the potential effects on elephants.

Oestrogen is also an agent which induces abortions in pregnant females and abortion of a near full-term foetus could have serious consequences for an elephant cow. The research group intended to treat non-pregnant elephant cows and they used an ultrasonic scanner to determine pregnancy in proposed research animals prior to insertion of implants. There was some concern as to whether the scanner would be a reliable indicator of pregnancy, but these concerns now appear to have been without foundation as the team conducting the scanning have shown that a foetus would not have escaped detection.

As the oestrogen implants would induce abortion in pregnant cows it was necessary to implant them in non-pregnant animals. Cows with very small calves are the only ones which are likely to be non-pregnant and thus they were selected as study animals, and all ten of the cows implanted had very young calves at foot. Treated elephant cows would absorb high levels of oestrogen from the implants and would pass much of this out through their urine in a metabolised form, incorrectly signaling to bulls that they were sexually receptive. The courtship behaviour and its accompanying disturbances described above would have been a condition which lasted as long as the implants were active (six months). Cows in this condition of "false oestrus" would not be sexually receptive and continual chasing or harassment by the bulls would likely be the result. This would almost certainly be highly stressful for the adult cows and even more so for the calves. Calves of less than a year old are very seldom found more than a few metres from their mothers (Moss, 1988). If these cows were continually chased by attendant bulls, the calves would be in danger of: being trampled by bulls (or by the mothers themselves in their efforts to avoid the bulls);

or being unable to suckle adequately while their mothers were harassed by bulls, possibly resulting in malnutrition and death from starvation.

The following are also considerations:

- High levels of oestrogen are known to have a suppressive effect on milk production. This type of contraception is not used on human females for this reason. This may also lead to malnutrition and possible death of these calves should this be the case in elephants.
- Concern has also recently been expressed over a possibility that high levels of oestradiol may cause permanent damage to the ovaries and thus permanent sterility.
- High levels of oestrogen in mares are known to induce diarrhoea in foals through ingestion of the milk -another possible health risk to the calves.
- Concerns have also been expressed over the possible effects that elephant cows in false oestrus may have on bulls and on their behaviour such as heightened aggression (Whyte, van Aarde and Pimm, In Press).

## MONITORING OF BEHAVIOUR

### Immunocontraception

Since it was not expected that the immunocontraception vaccine would have any significant adverse effects on behaviour, no provision was made for subsequent monitoring in the project protocols which were accepted by NPB staff. Follow up work would have been at regular intervals requiring only that the animals be immobilised for clinical examination. However, once the monitoring program had been instituted for the oestradiol implanted animals, the PZP animals were also occasionally visited.

### Oestradiol implants

No provision for the monitoring for adverse behavioural and other negative side effects were made in this project's protocols either. As members of DSS staff felt that this was imperative, it was instituted after the animals had already received their initial treatments. As this had not been foreseen, most of these research animals were unfortunately selected in areas which proved largely unsuitable for this work due to thick bush and mountainous terrain, which is evident from the results presented here. Elephants

Table 1. Results of ground and helicopter tracking of PZP treated elephant cows.

Collar Frequency	Times tracked	Cow seen?	Cow with herd?	Calf present?	Bulls present?	Harassed by bulls?
9165	1	0	-	-	-	-
4436	Collar ceased functioning					
4561	Collar ceased functioning					
9070	2	0	-	-	-	-
9080	11	6	11	6	2	-
9090	2	1	2	1	1	-
9160	3	0	3	-	-	-
9170	2	1	2	1	1	-
9180	0	Tracked only from the air				
9670	2	2	2	2	-	-
9680	3	0	3	-	-	-
9700	1	0	1	-	-	-
9710	3	2	3	2	1	-
9720	1	1	1	1	-	-
9750	2	2	2	2	-	-
9780	1	0	-	-	-	-
9790	11	6	11	6	2	-
9810	2	1	2	1	1	-
9820	4	1	4	1	1	-
9830	3	0	3	-	-	-
9840	3	0	-	-	-	-
Totals	57	3	56	23	9	0
%	100	40.4	98.2	100.0	15.8	0

were often tracked but the research animals could not be observed due to the thick bush and the danger of approaching these animals on foot. On more than one occasion, while “homing in” on the collared animal, the observers found themselves amongst the rest of

the herd which they had passed unnoticed before the research animal could be seen, and had to retire hastily before any observations could be made, and the cows were thus tracked more often than they could be observed.

Table 2. Results of ground and helicopter tracking of oestradiol- 17 $\beta$  treated elephant cows.

Frequency	Times tracked	Cow seen?	Cow with herd?	Calf present?	Bulls present?	Harassed by bulls?
<b>8270</b>	14	7	14	7	8	-
<b>8620</b>	8	5	8	1	3	-
<b>8110</b>	13	7	3	7	8	2
<b>8130</b>	11	7	10	6	8	3
8200	21	14	12	12	13	5
8810	17	9	17	9	10	-
8170	18	6	18	6	8	3
8100	4	2	4	2	2	-
8220	5	4	5	4	3	-
8660	11	6	11	6	4	1
Totals	122	67	112	60	67	15
%	100	54.9	91.8	89.6	100.0	22.4
- No data						

Table 3. Comparisons between tracking data from Immuno- and Oestrogen treated elephant cows.

Observation type	Immuno			Oestrogen			Chi-squared	p
	Yes	No	n	Yes	No	n		
Times tracked	-	-	57	-	-	122	-	-
Cow seen?	23	34	57	67	55	122	2.05	<0.1
Cow with herd?	56	1	57	112	10	122	1.79	<0.1
Calf present?	23	0	23	60	7	67	3.49	<0.1
Bulls present?	9	14	23	67	0	67	24.94	<0.001
Harassment?	0	23	23	15	52	67	4.67	<0.05

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## RESULTS TO DATE

### Immunocontraception

A sample of 19 adult elephant cows was immobilised and fitted with radio-collars to facilitate relocation and identification of each animal. All animals were given an initial inoculation of PZP vaccine at the time of immobilisation, followed by a second inoculation given three to five weeks later by remote delivery in the rump area of target animals by darts fired from a capture gun from a helicopter.

As was expected, no behavioural or other negative side effects have been recorded from this treatment, as the hormone system of the target animals is not affected. Results of tracking of these animals are presented in Table 1.

This table shows that the research animal could only be observed on 23 (40.4%) of the 57 times these animals were tracked from the ground. In 56 of the 57 times (98.2%), it was determined that the cow was with the herd. Of the 23 times that the respective research animal was seen, their calves could be recorded with them on all occasions (100%). Bulls were recorded with the herds on only 15.8% of occasions (nine out of 57 times).

The fixed-wing aircraft was used only to track these animals to establish their locality so as to facilitate their subsequent capture by helicopter. From a fixed-wing aircraft it was not easy to actually see the collared cow in the herd or to determine whether her calf was with her. The data from these flights were not considered comparable and have not been included in the above table.

After 12 months ultrasonographic examination revealed that eight of the 19 treated cows were pregnant. This gives some cause for concern over the efficacy of the method but possible reasons for this are given later in this report.

### Oestradiol implants

A sample of ten adult elephant cows was immobilised and fitted with radio-collars to facilitate relocation and identification of each animal. Each animal received five slow-release oestradiol-17 $\beta$  implants, inserted subcutaneously behind the ear in the neck area. Certain behavioural and other negative side effects were recorded from this treatment. Results of tracking of these animals are presented in Table 2. This table shows that the research animals could only be observed on 67(54.9%) of the 122 times these animals were tracked. On 112 of the 122 times

(91.8%), it was determined that the cow was with the herd. Of the 67 times that the respective research animals were seen, their calves were seen with them on 60 occasions (89.6%). Bulls were recorded with the herds on 100% of occasions (67 times) and harassment of cows by these bulls was observed 15 times of the 67 occasions (22.4%) that the cows were seen.

There are clear differences between the data presented in Tables 1 and 2, particularly with respect to the relative number of times that calves were recorded with the treated cows, the number of times bulls were recorded with them and the number of times that "harassment" was recorded. An analysis of these differences is given in Table 3.

Although hormone release from the implants was expected to last for only six months, ultrasonographic examination revealed that after 12 months, none of the treated cows were pregnant. This showed that oestradiol-17 $\beta$  prevents pregnancies in elephants. The examination also showed the uteruses of these cows to be still in the characteristic oestrogenic state (increased blood supply and sponginess). All blood samples taken subsequent to the initial treatment have shown that the oestrogen levels have remained within the normal range for elephants, but the fact that the oestrogenic state has persisted for at least 12 months, suggests that elephants are extremely sensitive to increased levels of oestrogen, which raises concerns about possible long-term or even permanent damage to the ovaries.

### Video material

During the initial phases of the monitoring of these animals, a video camera was used to try to record these behavioural aberrances. For reasons mentioned earlier (thick bush, difficult terrain), this was seldom possible, but recordings were made of bulls with penises erect following the treated cows, and of the red mud smears on a cows back which were clearly from the front feet of bulls trying to mate with her.

### Aggression by bulls

A report was received from Scott (In Litt. D/1/1: 97.03.17) which he wrote on behalf of the Trails Rangers and staff of the Boesma Area (a area where tourists are taken out on foot) expressing concern over an increased incidence of aggression by elephant bulls towards trailists subsequent to the commencement of this research. This was attributed to a increase in the number of "musth" bulls in the area utilised by oestrogen contracepted cows in the Matjulwane area.

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## DISCUSSION

### Immunocontraception

The results of the tracking of the immunocontraception cows are as would have been expected from cows whose behavioural patterns were not affected by the treatment. The calves were always with their mothers and, although bulls were occasionally recorded with these herds, this is normal as bulls do enter the herds to investigate the possibility of cows being in oestrus or for other social reasons (Moss, 1988).

The efficacy of this method is somewhat under question, as after 12 months, eight of the 19 cows were pregnant. This has been attributed to two possible causes. These were:

1. The most likely cause was that pregnancy had occurred before the antibody titres had achieved levels high enough to prevent conception.
2. A less likely cause was the possibility of non-delivery of the booster doses when delivered remotely (by darting). Darting is known to be an imperfect delivery system as even when using this method for immobilisation, failures sometimes occur.

### Oestradiol implants

The cows treated with the slow-release oestradiol-17 $\beta$  implants showed definite behavioural aberrances. Firstly, calves were not always recorded with their mothers. This is highly unusual. Moss (1988) describes the normal situation for young calves as follows:

“The calf is very rarely more than a few feet from its mother and usually less than a foot from her, often touching her by leaning on her leg or by resting its head against some part of her body.”

Calves were not with their mothers in seven out of 67 observations and is, therefore, considered highly abnormal. Although this could not be shown to differ significantly from the immuno sample by statistical analysis, this is considered to be due to the relatively small sample size of the “immuno” sample.

There was evidence that milk production was affected as poor milk samples were obtained during some of the scheduled recapture operations.

Two of the ten calves disappeared and were presumed dead. This could not be directly attributed to the oestrogen treatment, but given the above results

(probable poorer milk production and separation from their mothers), and the fact that none of the PZP treated animals' calves died, it is considered probable that the disappearance of the calves can be attributed to the gestrogen treatment.

Cows were recorded to have become completely separated from their matriarchal groups on ten of the 122 occasions that they were tracked. On one occasion, the cow was tracked by fixed wing aircraft and was completely on her own (no other cows and/or calves could be seen anywhere nearby) in the company of seven bulls. This is also not normal behaviour for a cow not in real oestrus. Bulls were recorded with the herds in a far greater proportion of times (100%), and harassment of the cows was recorded in 15 out of 67 observations. There is evidence of bulls trying to mate with cows during darting and also from video material. During normal oestrous behaviour the cow does often become separated from her matriarchal group, but this lasts only for a few days during which time the cow is receptive and willing to mate. At this stage the calf is old enough to be separated from its mother for short periods. With the oestrogen treated animals, this false oestrus is a permanent condition (while the implants remain active), the cows are not receptive and willing to mate, and under these conditions, the attentions of the bulls must be considered to be harassment, particularly with the added stress of being separated from their young calves.

However, the method appears to be successful as a contraception technique as ultrasonic scans showed that after 12 months, none of the ten cows was pregnant.

## CONCLUSIONS

### Immunocontraception

There is no evidence to suggest that the immunocontraception technique is having any adverse effects on the behaviour of either the treated cows, their matriarchal groups or the bulls.

The efficacy of this method needs further research to determine the reasons for some of the cows returning to breeding condition.

### Oestradiol implants

All of the behavioural differences discussed above must be considered as abnormal and must have placed severe stress on the treated cows which in our opinion, were unacceptable on both humane and ethical grounds. It

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would seem that the effects of the oestradiol are no longer having any effect on behaviour and thus do not need to be removed.

None of the treated cows is yet pregnant and so there is either still enough oestrogen being released by the implants to prevent ovulation or else there has been a more long-term or possibly permanent effect on the ovaries.

## ACKNOWLEDGEMENTS

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