

White rhinoceros
or square-lipped
rhinoceros
(*Ceratotherium
simum*).



MATE CHOICE!

Mate choice, reproductive success and
inbreeding in white rhinoceros: New insights
for conservation management

By Dr Petra Kretzschmar
Photos courtesy Thaba Tholo Game Farm



40 years ago, William Conway, a pioneer in conservation breeding, noted that breeding farms and ranches will be needed to provide sufficient land for conservation of species (De Wildt et al, 2019). Today, we are in a period of mass extinction. The survival of many species, especially that of large herbivores in Africa, is threatened by poaching, habitat loss and resource competition with livestock. As a consequence, the available land for conservation is scarce and many species are isolated in islands of protected areas, which are only fractions of their historical range (Ripple et al, 2015).

Game farms, which are large enough to sustain herbivore populations such as African rhinos, are therefore becoming more important for the protection of these highly endangered species. Currently they hold nearly half of the South African rhino population and have higher budgets for their protection than state-owned conservation areas. In the near future they may even become the last refuges for the species.

However, **the conservation of isolated rhino populations is challenging.** Currently the poaching crisis is the main threat for the survival of the African rhinos. Every year hundreds of individuals are slaughtered for their horn and the protection against poachers costs a fortune. Yet, there is another threat to the survival of the rhinos that has so far been neglected – the low genetic diversity of the species and the risk of a further reduction in diversity due to inbreeding.

“There is a threat to the survival of the rhinos that has so far been neglected.”



Dr Petra Kretzschmar

Research fields and interests

I am working with free-ranging and captive African and Asian rhinos on private game farms in South Africa as well as in a national wildlife reserve in Asia. My work involves research as well as dialogues with politicians, NGOs and the industry. My research interests include mate choice, territorial behaviour, habitat use, conservation of endangered species, habitat restoration and captive breeding.

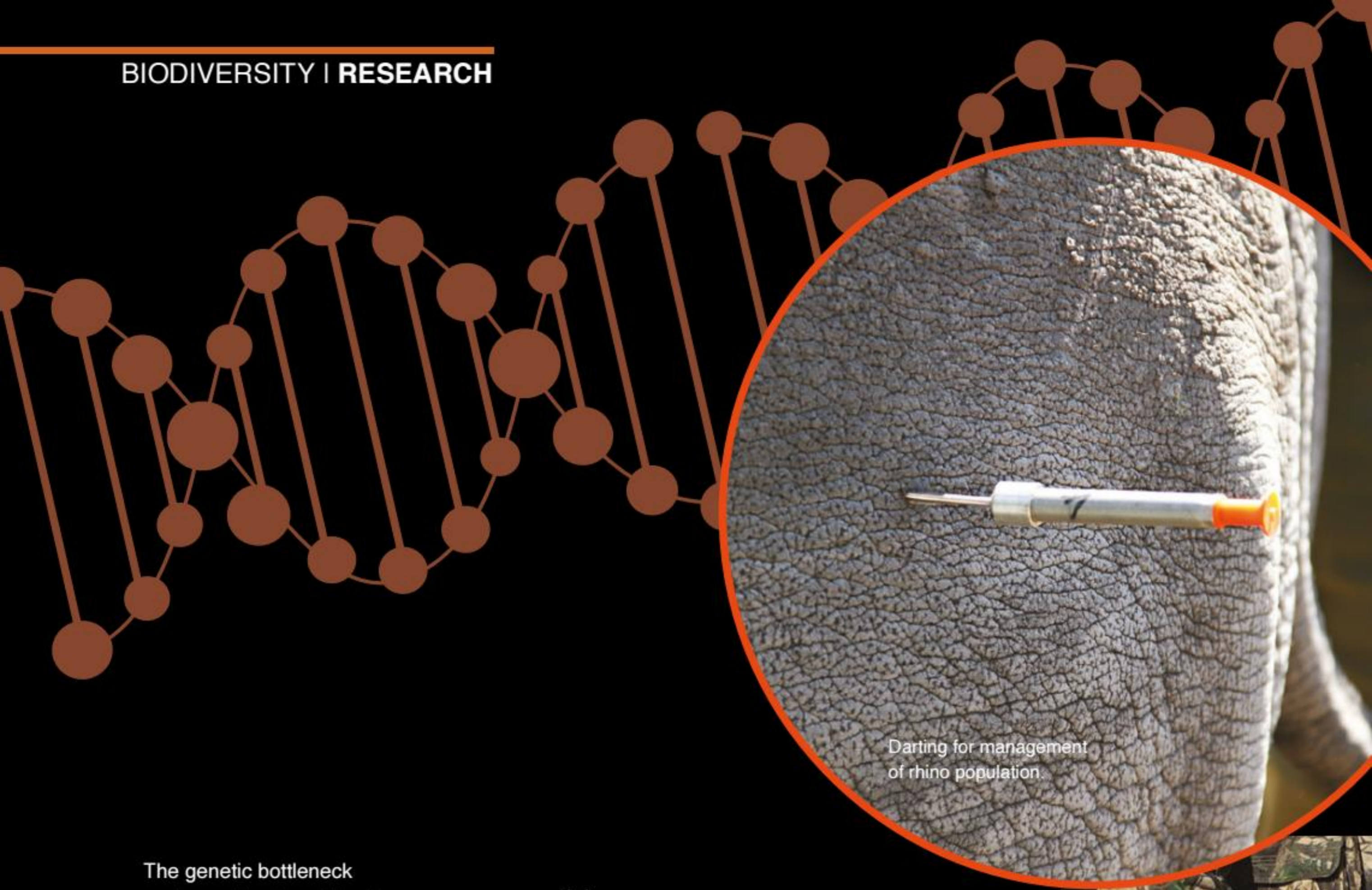
Dr Petra Kretzschmar Scientist at the Leibniz Institute for Zoo and Wildlife Research in the Department of Evolutionary Ecology

Director of the Rhino & Forest Fund

Member of the IUCN Asian Rhino Specialist Group

Sabah Rhino Project Coordinator

© kretzschmar@izw-berlin.de



Darting for management of rhino population.

The genetic bottleneck experienced by the white rhinoceros during the colonial period and several population crashes in prehistoric times (Moodley *et al*, 2018) lead to the fact that the white rhinoceros has a much lower genetic variability than any other rhinoceros species (Guerier *et al*, 2012). Inbreeding depression, such as juvenile mortality and abortions, have not been described in white rhinos yet. However, it is likely that a further reduction in the genetic variability of the species will result in reproductive problems, which are known from many other species, including various ungulates (Ralls *et al*, 2008).

In addition to these rather short-term problems, the rhino may also lose its adaptive flexibility (Ralls *et al* 1979; Frankham *et al*, 2002; Giglio *et al*, 2016)

“One of the major challenges for the preservation of the white rhino is therefore to identify the risks that individual rhino populations are facing and to minimise these risks by managing interventions.”

and may thus not be able to adapt to changing environmental variables, such as climate change or new emerging diseases.

This leads me to my study on the mating behaviour of the white rhinoceros at the Thaba Tholo Game Reserve in South Africa.





The aim of this study was to assess the degree of inbreeding in white rhinos. In particular, I wanted to find out whether females are able to choose unrelated males as mating partners, which would enable them to actively avoid inbreeding. Additionally, I wanted to establish whether females mate equally with all territorial males in a population or whether they prefer a territorial owner that is characterised by certain male and habitat characteristics.

“The aim of this study was to assess the degree of inbreeding in white rhinos.”

At that stage we only knew that white rhinoceros have a territorial-based mating system, where adult males that are old and strong enough to defend their own territory, dominate all mating activities. It was also known that young sexually mature males between seven and nine years of age do not defend a territory and do not participate in breeding (Owen-Smith, 1975; Rachlow *et al.*, 1998).

The territorial-based mating system reduces the number of breeding males within a white rhino population to a few individuals. A further preference of individual territorial males as mating partners would lead to an even stronger bias in the breeding sex ratio and could result in a high degree of inbreeding.

To answer these questions, I combined 13 years of field observations with genetic paternity assignments of 104 offspring with known mothers. My study thus represents the largest paternity analysis ever performed for any species of rhinoceros. I collected various data of individual animals, such as the body and horn size of territorial males, the food quality in the male territories and the hormone concentration in their faeces.

Additionally, I assessed the degree of relatedness between males and females to identify whether females avoid close related males as mating partners.

I was lucky that I could compare the influence of the different traits on two different groups of territorial males, which were introduced sequentially – with removal of the first set of males – into the same population of females. This was due to the fact that the white rhino population on Thaba Tholo was managed in such a way that all territorial males were exchanged on a ten-year basis in order to prevent inbreeding.

“The white rhino population on Thaba Tholo was managed in such a way that all territorial males were exchanged on a ten-year basis in order to prevent inbreeding.”



Rhino ear-notching, implanting an identification tag and collection of DNA assist owners to monitor and manage their rhino population.



Photo © Robynne Prinsloo



Scan the QR code or visit youtu.be/SPZoO3powOk to watch the video, 'Mating Behaviour of White Rhino'.

The results of the study clearly indicate that the mating behaviour of the white rhinoceros leads to a reduction in the genetic diversity:



- 1 There was a strong skew in the reproductive success among territorial males,
- 2 There was a lack of inbreeding avoidance during mate choice, and
- 3 Half of all females that produced multiple offspring were monogamous and thus mated during consecutive breeding seasons with the same male.

In a natural situation where rhinos can roam freely, this characteristic mating behaviour would not be a problem. Yet, in the current situation where fences and other barriers prevent dispersal and immigration between different rhino populations, it leads to inbreeding and the loss of genetic variability. White rhino therefore need careful management in order to best preserve their already low genetic diversity.

“White rhino need careful management in order to best preserve their already low genetic diversity.”



There are a number of strategies that can be used to increase the genetic variation in isolated rhino populations.

When pedigree information is available, a management option could be to aim to selectively remove monogamous females or males that have sired many offspring. Another option could be to retain individuals with specific rare alleles in the population.

When genetic data is not available, the introduction of individuals from outside of the population is advisable. As mentioned, in the Thaba Tholo population, all territorial males were exchanged every ten years to avoid inbreeding. Nevertheless, I still observed a case of incest, which indicates that the ten-year time period was already too long and should be shortened to six years, the time period when young females reach sexual maturity (Owen-Smith, 1975).

I was not able to identify any environmental factor that clearly influenced the reproductive success in the white rhinoceros.

Nevertheless, knowledge about such traits would help to influence mate preference. For example, the supplement of water or food in certain areas can change the habitat quality (Cinková *et al*, 2017) and thus potentially the reproductive success of individual males.



Calling all private rhino owners! Get involved!

As a follow up of my study, I plan to compare the genetic diversity of several white rhino populations that are kept under different management regimes, such as in intensive breeding camps or in national parks. The idea is to identify the best management measure that helps to prevent the loss of genetic diversity in the species. *For this study I am still looking for samples as well as funding and I highly welcome any kind of support.*

To participate in the follow-up study contact Dr Petra Kretzschmar:
 @ kretzschmar@izw-berlin.de

Access the full paper:

onlinelibrary.wiley.com/doi/full/10.1111/eva.12894



ENDORSEMENT



Dr Michelle Otto



'Spartacus' was rhino calf number 1 000 born at Buffalo Dream Ranch in 2017.
Photos © Quintus Strauss

Dr Michelle Otto, resident veterinarian for John Hume, the largest private rhino farm breeder in the world, Buffalo Dream Ranch.

It is a well-known fact that the southern white rhino have already undergone a genetic bottle neck. Having had their wild number reduced to less than 50 at the onset of the 1900s in a single location, the ability of the southern white rhino to have recovered genetically to several viable populations today is remarkable. Of course, this could not have been accomplished if not for the sustainable conservation programmes that led to the translocation of rhino from this small, isolated population to several other locations such as the Kruger National Park in the 1960s, as well as allowing private land owners to establish their own southern white rhino breeding populations.

This spatial distribution definitely helped relieve pressure on the high degree of inbreeding that must have occurred due to the limited number of individuals left in the wild population in the 1900s. That being said, with the ongoing losses of rhino being poached, as well as loss of present day breeding populations due to disinvestment by rhino custodians as a result of the rising costs of security and the risk involved in taking care of rhino under the current circumstances, proper biological management of the remaining breeding populations is now more vital than ever.

It is our responsibility as rhino custodians to ensure that proper

genetic management is done whenever possible.

Knowing there is already low genetic diversity in our southern white rhino today, doing more research such as this is important and will become a key component to help rhino custodians make informed decisions and help guide them in the management of their breeding populations. Knowing that rhinos don't have an inbreeding avoidance in mating choice, for example, should motivate us to ensure that we remove progeny timeously from their parents to reduce the risk of further inbreeding if possible. If we as rhino custodians are willing to help one another and share or exchange rhino (or genes) amongst our different breeding herds, we can try and promote genetic variance as well.

We have the ability and knowledge to help this iconic species survive. It falls on us to give them the best chance of recovering from this onslaught and threat of extinction. By working together and making more informed decisions, we can.

Dr Michelle Otto

otto.michelle84@gmail.com

ENDORSEMENT



Rubin Els

Rubin Els, former CEO of Thaba Tholo Game Farm.

– stamping her footprint on the African soil. She was relatively inexperienced regarding African bush conditions, and particularly, rhino in the wild. However, when she was thrown into the deep end, it was a sink or swim situation for her, with limited assistance from the Thaba Tholo personnel.

Petra rose to the occasion and did not just manage to survive her first few years in the bush, but continued her research and in so doing, managed to document extremely valuable data.

She collected and processed tons of rhino dung – a seemingly futile exercise at the time, but one that ultimately yielded fantastic results. Many aspects discovered during her research will be of immense practical value to rhino owners, game reserves and the wildlife industry as a whole.

“I am privileged to know Petra as a friend but also as a scientist advisor on all rhino matters at Thaba Tholo. Her research, I believe, will become an invaluable source of information to all rhino owners and keepers.”

Rubin Els

✉ info@rhinoalive.com

🌐 www.thabatholo.co.za



I have known Dr Petra Kretzschmar since her student days in March 1997. She was awarded an opportunity to do her doctoral thesis on white rhino at the Thaba Tholo Game Ranch by the visionary businessman and conservationist Tilman Ludin.

At that stage, Petra was enthusiastically focused on – and had a dogged determination towards

