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# Vocal and olfactory communication of the white rhinoceros

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## 1) INTRODUCTION

My study at Lapalala Wilderness is part of my long-term research on the vocal and olfactory communication of northern (*Ceratotherium cottoni*) and southern white rhinoceros (*Ceratotherium simum*) conducted from 2009 in South African wildlife reserves (Lapalala Wilderness, Welgevonden Game Reserve, Mthethomusha reserve, Lichtenburg biodiversity conservation centre) and in European zoological gardens (Dvůr Králové, Salzburg, Bratislava, Zlín).

White rhinos have poor reproduction in captivity (e.g. Hermes et al. 2005, 2006; Cinková and Bičík 2013) and they also do not breed optimally in smaller African reserves, where only a few rhinos are held. They are the most social from all rhino species (Penny 1987); adult bulls are territorial while females, subadults and juveniles live in groups in overlapping home ranges (Owen-Smith 1973, 1975). The most important for communication of white rhinos are vocal and olfactory signals (Penny 1987). Main objectives of my field work at Lapalala were to conduct playback experiments, to record the calls of the rhinos and to study their olfactory communication. The focus of my vocalization research was to study the role of contact pant call and hic call, in their social and reproductive behaviour. Hic call is only made by the adult bulls during the approach or olfactory investigation of a female, mainly during courtship (Owen-Smith 1973).

The aims of my study:

- Do the contact pant calls of northern and southern white rhinos allow identification of individual identity and species of calling animal?
- Are the rhinos able to recognize sex, familiarity and species (northern x southern white rhino) of an animal based only on its contact call?
- Do the rhinos react differently to the hic and pant calls?
- Are there differences in the reactions of particular sex-age classes (adult bulls, cows and subadults) to the pant and hic calls?
- Are the rhinos able to recognize familiar and unfamiliar male and female conspecifics only according to the smell of their dung?
- Are there bioacoustic differences in the vocal repertoire of northern and southern white rhinos, which has been until now described only verbally?

Better knowledge of white rhino communication might be very helpful in the management of species and allow:

- stimulation of social and reproductive behaviour of the rhinos by playbacks of pant and hic calls or by presenting dung of unfamiliar rhinos
- to influence post-release movements of rhinos by olfactory or vocal signals of familiar/unfamiliar rhinos

#### ♣ VOCAL COMMUNICATION

White rhino contact call pant, which is a series of inhalations and exhalations, does not have any known parallel in the calls of other rhino species (Budde and Klump 2003; Laurie 1978; Goddard 1967), which is most probably caused by a more pronounced social system of white rhinos and also by an open habitat, where they occur (Policht et al. 2008). Acoustic communication is advantageous for carrying information at longer distances than can be achieved by chemical or visual cues (Kondo and Watanabe 2009) and vocalizations can also potentially carry information about the signaller.

For any significant information contained in any calls is important low within-group and high between-group (e.g. low within-individual and high between-individual) variation. In addition to chemical signals, individual variation in calls might enable rhinos to identify each other with higher accuracy. Differences in hic call between the males might also indicate the quality of the male and therefore influence female mate choice as has been shown for example in red deer (Charlton et al. 2007).

When studying information contained in the calls of any species, various parameters of recorded calls are measured. Most measures are taken from the following three forms of call presentation (Terry 2005):

- ⇒ waveform – shows changes of amplitude (= acoustic pressure) in time and is suitable for measuring temporal variables such as call duration.
- ⇒ power spectrum – is generated from the waveform and shows changes of amplitude at various frequencies. It is suitable for measuring e.g. dominant frequency.
- ⇒ spectrogram – is three-dimensional display plotting frequency against time. Amplitude is shown as intensity of either grey scale or colour. Spectrograms are used for visualizing sounds.

Once the parameters of the calls are measured using acoustic programmes, discriminant function analysis (DFA) is run to determine which parameters discriminate best between two or more groups. DFA combines parameters with weighting coefficients to create a set of functions that can discriminate between groups. The result of DFA is then the percentage of cases correctly classified to pre-existing groups (Terry 2005). However, in this way, the classified objects are the same as those used for the calculation of discriminant functions. The results are therefore likely to be overestimated in this way. To avoid this, a cross-validation using 'leave one out' procedure may be used. The discriminant functions are then derived from all objects except for the one, which is being classified. This process is then repeated until each object was left out once (Norušis 1994; Bortz 1999; Tabachnick and Fidell 2001; all cited in Mundry and Sommer 2007).

## 2) SOUTHERN WHITE RHINO VOCAL REPERTOIRE

The vocal repertoire of the northern white rhinos was bioacoustically studied by Policht et al. (2008) while the vocal repertoire of southern white rhinos was only verbally described (Owen-Smith 1973). White rhinos are the most vocal when the different groups meet, when a bull is interacting with females or also in long-term groups, which consist from three or more animals. During the field work in several reserves, I could observe the rhinos in various social situations, which allowed me to record a wide diversity of their calls. Below, there are recordings of most important calls in southern white rhino vocal repertoire:

Calls used in sociopositive interactions:

- Whine is produced most often by the calves before suckling and is usually repeated in series.

Whine of a calf towards its mother

- Squeak is a short high-pitched call, is only rarely heard and is emitted usually by calves after visual separation from their mother, by subadults after visual separation from their group members or also by subadults being chased by a territorial bull.

Squeak of a subadult male while being chased by a territorial bull

- Squeal is a high-pitched sound rising and then falling in tone. It resembles calves' whine and is made by a bull at a territory boundary when he is trying to prevent a cow from leaving his territory.
- Pant is a contact call and is directed towards a particular conspecific during positive social interactions, e.g. when approaching, following or greeting another rhino or during separation from a herd.

Pant of a female towards her companions

- Hic is internal part of pant call and is used by males when approaching a female, usually in oestrus. A bull continuously follows a cow for two or three weeks before she comes to an oestrus. A day before mating, a bull starts approaching a female intensively and is repeatedly calling with hic. During such attempts a female and her companion(s) often react towards bull's approaches with agonistic calls. Hic is distinguished from pant by the choking pattern of breathing.

Hic of a territorial bull towards a cow in oestrus several hours before their mating

Calls used in agonistic (aggressive) interactions:

- Threat is used during aggressive interactions, usually is apparently directed to a particular individual and can be regarded as a first warning towards an approaching animal.

Threats of a cow towards an approaching bull



*Typical posture of a cow during threat*

- Grunt is a low frequency vocalization used in aggressive interactions and most often is directed towards a particular individual.

Grunt of a cow towards a subadult male, who was in long-term group with her

- Snarl is always accompanied by a snarl display: ears laid back with mouth opened and head thrust forward. Snarl is used exclusively in aggressive context and most often is directed from the adult females towards a bull.

Snarls of a subadult female towards an approaching bull

- Shriek is made by subordinate bulls, territorial bulls out of their territories or subadult males when they are confronted by a resident territorial bull.

Shriek of a subadult male while being chased by a territorial bull

- Gruff-squeal is usually repeated in series. It is made by territorial bulls when chasing after other rhinos, usually subadults. The sound seems to emphasize bull's presence and his threat.

Gruff-squeal of a territorial bull while chasing a subadult male

### **3) INDIVIDUALITY AND SPECIES DIFFERENCES IN CONTACT CALLS OF SOUTHERN AND NORTHERN WHITE RHINOS**

#### ☛ Material and methods

I analysed 385 pant calls from 20 animals: six northern (four females, two males) and 14 southern (eight females, five males) white rhinos, which were recorded in several zoological gardens and wildlife reserves. Each animal contributed from 5 to 53 calls into the analysis. We also included calls of three animals (Munyani, Medupi and Lekoto) recorded at Lapalala. Only calls recorded in a good quality were included into the analysis (e.g. calls with limited background noise). Acoustic programmes Avisoft SAS Lab Pro 5.2.07 (Avisoft Bioacoustics, R. Specht, Berlin, Germany) and LMA 2008 (kindly provided by K. Hammerschmidt) were used for the analyses and call parameters were measured in a combination of manual and automatic procedures. After selecting the most important parameters, stepwise discrimination function analysis (DFA) was conducted. To validate the results of DFA and to avoid their overestimating, we used a cross-validation ('leave-one-out' procedure).

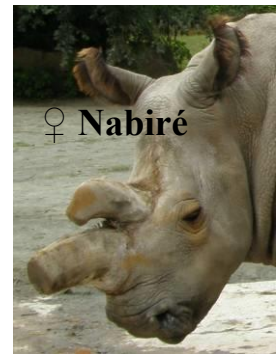
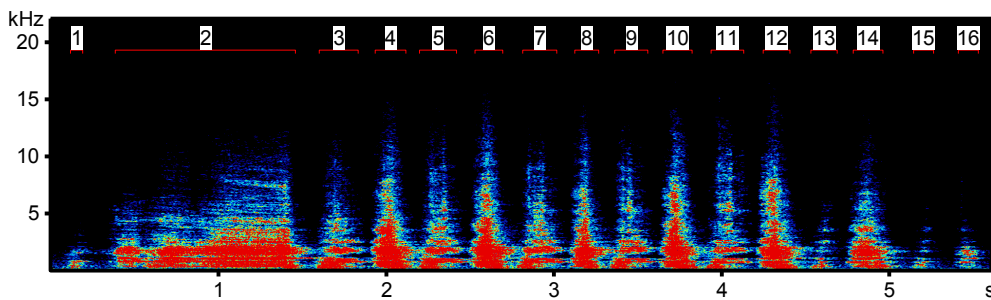
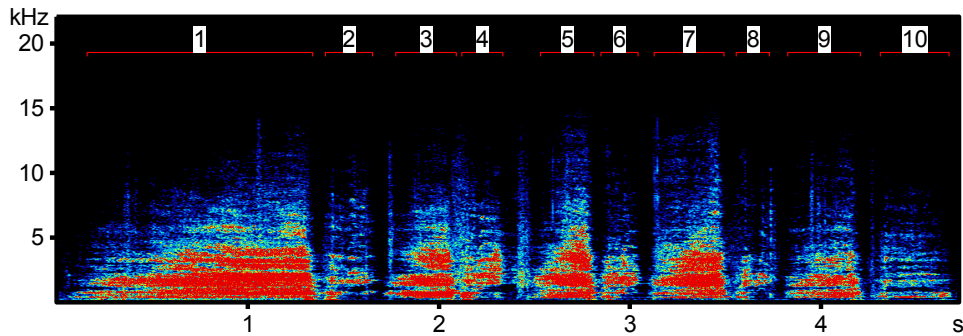
#### ☛ Results

Our results showed that the pant calls of white rhinos contain information on the individual identity of calling animal and the DFA assigned 86% (77% cross-validated DFA) of calls correctly to particular individuals, which is significantly more than would be expected by chance (only 5% of calls could be classified correctly by chance). The most important parameters for individual identification among the animals were mainly temporal parameters (as e.g. call duration or duration of the longest inhalation in call). The calls also differed between the northern and southern white rhinos; we found

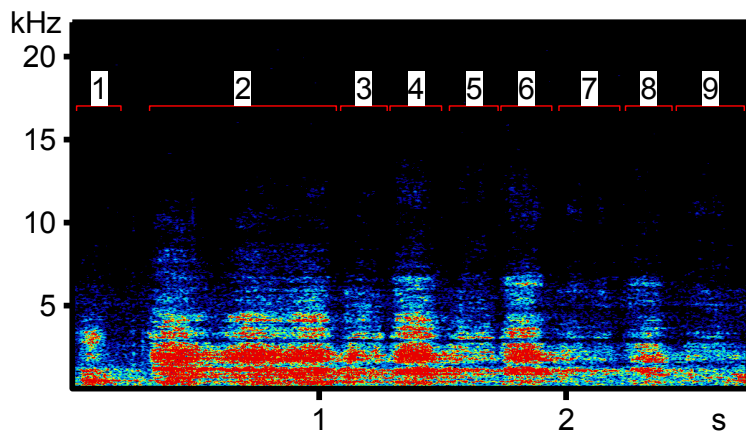
differences between them in several call parameters. Our results also suggest the influence of age-class and social status on the call structure of males.

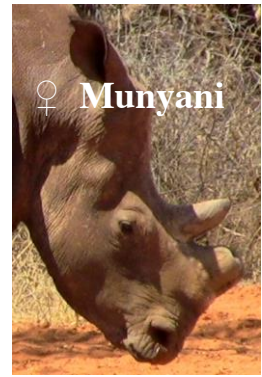
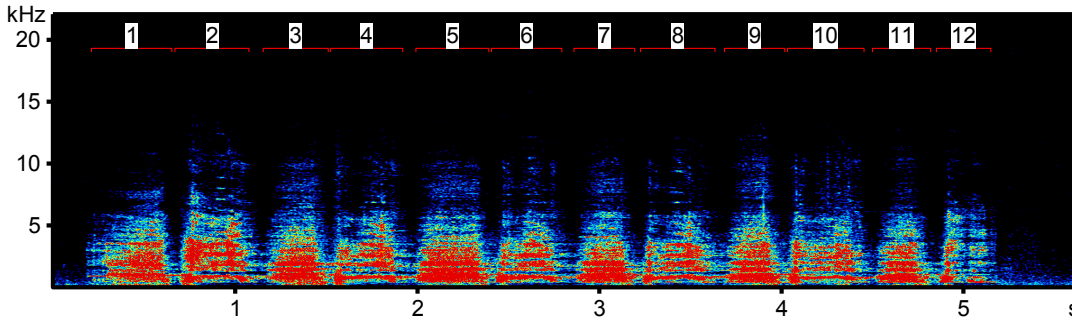
The results of this study are currently shortly before submission to a scientific journal.

*Spectrograms of pant calls of northern white rhinos with marked call elements:*



*Spectrograms of pant calls of southern white rhinos with marked call elements:*





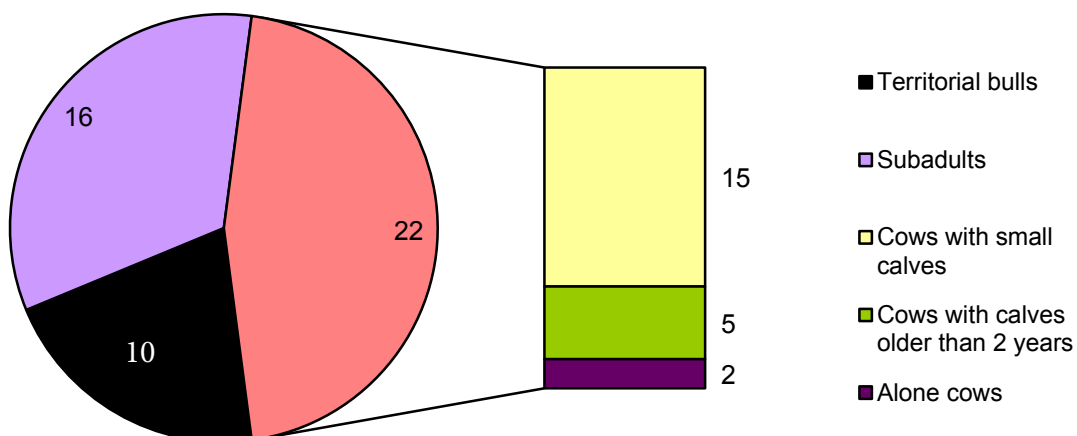
#### 4) PLAYBACK EXPERIMENTS

##### ♣ Material and methods

A maximum of two playbacks of pant calls per day were played to a tested animal and there was several-day-pause between consecutive experiment days. Playback volume was standardized and corresponded to a natural amplitude of pant calls.

##### ♣ Results

At Lapalala, I included 17 animals into the study (3 adult males, 7 adult females and 7 subadults). Number of animals from different sex-age classes included into the project during the whole period of the study in several reserves is shown below.



*Number of animals from different sex-age classes included into the study with playback experiments*



Example 1: Reaction of bull Poacher to a playback of contact pant call of unfamiliar northern white rhino male

Poacher got up, approached the speaker, called back (cannot be heard much on the video), scrape marked and spray urinated and was walking around and searching.

Example 2: Reaction of female Honkey to a playback of unfamiliar southern white rhino female

Honkey called back after the playback, was running towards the speaker and walking around.

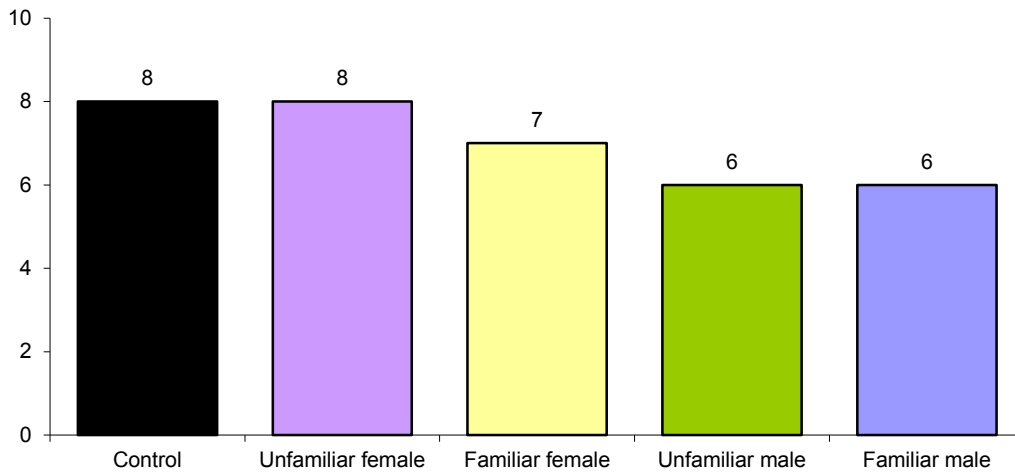
## 5) OLFACTORY COMMUNICATION

### Material and methods

Methodology of olfactory communication study was changed following the start of the project. A camera trap, which I was planning to use for the project was unfortunately destroyed by an elephant during the first week of its overnight use. The rhinos were therefore followed and when they seemed to start approaching dungheap, experimental dung was placed there and the rhinos were video filmed. This method then proved to be better than originally planned use of a camera trap. The experiments were only included when a rhino came to the dung and started smelling it. Only like this, I could be sure that the rhinos were aware of the dung and noticed it. The duration of persistence of volatile structures in white rhino dung is not known yet so to assure the freshness of experimental dung, it was only used within 12 hours after being defrosted. However, another study proved that the black rhinos were interested in the dung of their conspecifics and showed similar reactions to it when it was either one day or 30 days old (Linklater et al. 2013). Only one reaction of particular animal (either to control, dung of unfamiliar x familiar female, unfamiliar x familiar male) will be included into the study as it proved to be extremely difficult to obtain a reaction from a same rhino to all five treatments.

### Results

Territorial bulls were interested in the experimental dung the most and reacted more intensively than females, subadults and juveniles. In total, 35 animals were included into the study (see below).



*Number of animals in each treatment included into olfactory experiments*



*Kedibone sniffing the dung of unfamiliar territorial bull*



*Dung for trials (at the back) was placed in 2 kg portions in the vicinity of already established dungheaps (on the right). Tested animals also often defecated nearby (two dung piles in front)*



*Trial with dung of unfamiliar territorial bull – bull Motopi was sniffing and digging it*

## 6) NOTES

In attached file “Rhino sightings 2012”, there are GPS positions and groupings of all sighted animals. Only the first sighting of particular animal per day was noted.

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