

Communication types in Indian Rhinoceros (*R.unicornis.*, *Linn.*)

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Abstract: Great Indian one-horned rhinoceros can communicate very systematically with other rhinos in spite of being solitary in nature. Having poor eyesight they rely more on their acute sense of smell and on auditory signals. For that reason, they can emit ten types of vocalisations every one of which has a separate meaning. By sniffing dung piles they can understand who had defecated there before, what are their reproductive status and can understand the details of their age and sex categories. The sounds emitted during aggression and foreplay with the opposite sex are quite distinguishable. In 38.5% cases, the cows were the first defecators and next followed by the bulls. Only in 18.3% of cases, the opposite was true. Before and after defecation they broadcast some communicable signals like, earth scrapping over their own dung, dung scrapping, foot-dragging etc. which are very much meaningful. Recently discovered hidden chemical clues in the dung piles are also very informative to them. The least important communication system in them is the visual and tactile signals.

Keywords: Communication, Scent Marking, Dung Piles, Sequential Depositions

I. INTRODUCTION

Great Indian one-horned rhinoceros are not that much social as is the Indian elephants or Indian gaurs or wild buffaloes, either in wild or in captivity. Rather, they are mostly solitary in nature, particularly the adult bulls; only some gregariousness are seen in temporarily formed sub adult groups but bondage is seen only between mother and younger calves. Due to their likings to individual living, one can think that their communication systems are not very developed, but it is not true. They can keep contact with their fellow individuals very well and systematically. They can search their mates when they are not viewed even at a long distance. They can feel the existence of their competitors and react accordingly, can detect the con-specifics by a deep sense of smell, can hear the slightest drifting sound by strong hearing capacity and can feel the upcoming danger. Having a bit poor eyesight they are gifted by an acute sense of hearing and smell. For this purpose, they use to drag their dung after defecation to give some communication signals to others, either showing the territoriality to the other bulls or showing some attractions to their mating partners. Apart from the above-mentioned qualities, they can also emit ten different kinds of distinctive sound (Laurie, 1978), each of those is communicable and sensible to others. However, due to poor eyesight, they rely heavily on smell and hearing sounds.

II. METHODOLOGY

The study on the communication types on Indian rhinoceros was a smaller part of the total study on the Ecology and Behaviour of Great Indian one-horned Rhinoceros did at Gorumara and Jaldapara Wildlife National Parks time to time from 1980-1983, 1984, 1987, 1993 to 1995 and 2017-2018. In the initial periods, the population of rhinoceros in both the National Parks was very low. For this reason, I had to wait for

many days to record any particular behaviour desired for. After 1993 the rising of their population gradually got momentum and study on them became easier. During this long period (almost 40 years span) many rhinos died by infighting, many were poached for their horns, in a few cases natural death occurred, and in the latter years' many calves emerged into adults and they also turned into parents and produced calves. So, it became gradually difficult to track any particular rhino. I think the older rhinos who survived in the early eighties all were died by 2000.

In the starting years, the sound recording system was very primitive, a Philips tape recorder could catch their vocalisations very feebly, or the recorded sounds were almost inaudible, while, the sounds emitted by them were clearly audible to my ears. For clear viewing, I used an 8x25 zoom binocular. However, I could trace their footprints, by placing a square glass sheet attached with tracing papers (Bhattacharya, 1993) and in course of time I could learn which footprint belonged to whom and who was following whom, who had defecated, and by dung scrapping who was giving a signal to whom. I considered all these unforeseen behaviours as a deep-rooted communication system among them and all were noted in my field study sheets marked with the date and time.

I found that the strong odour of their freshly deposited dung, sometimes associated with spraying urine and dung scrapping was an important signal to the other rhinos, particularly to the breeding cow or bull. I recorded the successive depositions made by the two or more rhinos in the isolated places. The photographs were taken by an Ashahi Pentax ME camera, 1:1.4 lens and in some cases sketches were drawn in my field notebook.

III. RESULTS AND DISCUSSIONS

Vocalizations: I used to hear different sounds made by the rhinos, either from a distance or from the other side of the bushes. While grazing, the grazing sounds (tearing, breaking and chewing of the coarse grass) were often associated with an exhalation of audible deep breathing sounds. When a mother rhinoceros became separated from her newborn calf, for instance, she used to call the infant with breathing pants. During the intra-specific encounter, they used vocalizations producing different sounds in different situations conveying different messages which included snorts, grunts, moos, squeals, growls etc. But, from my field diary, the two types of sounds created interest to me which are as below:

It was a cool afternoon of January 1981. A faint grazing sound was nearing to our camp, the source of that sound was originating from the left side of the fire line which went straight to the Jaldhaka river (some 2 km away). Due to tall elephant grass and reeds, the animal could not be viewed but the nature of the sound of tearing and chewing grass was felt like a rhino. Suddenly one medium-sized elephant, almost 100 metres away from us, appeared from the right side of the fire line and entered the left side leisurely.

Within half a minute we heard a loud threatening sound and a male rhino came out from the left side of tall grass hide and chased the elephant along the fire line. Readily we could identify the rhino as GB02 (Gorumara Bull No.2) who had a reputation of being bad-tempered and about a month ago he ousted the bull GB01 after an intense battle. The sound emitted was very loud and repetitive, divisible into four syllables like below:

FAA – FAA – FAA – FAA .. (1)

Syllable: 1 2 3 4

All the syllables were forcibly emitted and were of equal strength. I realized that when even the last syllable had a force like first one then it proved to be the sign of anger and hostility indicating an aggressive call. The rhino was not ready to tolerate the presence of a stranger which was slightly bigger than him as per our eye estimation. It was an example of interspecific aggression.

The elephant did not take any risk of the fight and quickly ran out of our sight. After some time the rhino again returned to its original place showing the winning sign in its body language. He did not bother about the size of the competitor thinking himself as the king of his domain.

Latter in the next month (February 1981), in the same block (Garati block), when I was following the tracks of rhino along a rhino route, all on a sudden, I discovered the existence of two adult rhinos, one male and another female. In the first case, they were staying apart with a large reedy bush and trees in between and could not view each other. In the latter case the female stood still perpendicularly near to the male and the male rhino emitted the sound as under:

FAA – FAA- FAA – FAA-FAA-FAA-FAA .. (2)

Syllable: 1 2 3 4 5 6 7

and

FAA- FAA – FAA || FAA- FAA – FAA|| FAA- FAA - FAA || FAA- FAA – FAA...(3)

1 2 3 4 5 6 7 8 9 10
11 12

(Block letter indicates forcibly emitted sound, || indicates little pause)

I could identify the sounds made by the male as pre-mating call and from that day I could able to distinguish clearly the differences between the pre-mating call with that of aggressive call. The pre-mating call had the characteristics:

(Upper): The sounds are divisible into seven syllables, first two syllables emitted loudly then gradually the emitted sounds diminished and last one or two segments were almost inaudible and there was no pause in between the syllables. It means when the partner is not near but her presence is felt and after emission of the sound, a long pause is sustained.

(Lower) it indicates when the male and female is very close, courtship play is about to start, comprising of repetitive 3 syllables and there is a little pause after every three syllables. Again, each block of three syllables is the exact copy of the other blocks. In the aggressive call, all the syllables are distinctively clear and are of equal force but suddenly stops.

The above observations prove strongly that the Indian rhinos use different kinds of vocalizations in a different situation, either it is loud or little sigh. Each and every sound emitted by

them make a meaningful sense and the receivers can understand very well what the donors are saying.

Laurie (1978) did some extensive works in Nepal on Indian rhinoceros' behavioural study and he identified ten different sounds produced by them. Reed (2017) explained the sounds of Sumatran rhinoceros as stringing together a series of sounds and finally emitting a "song", one of which is heard like the song of a humpback whale. Mayer (2012) opines that the screaming sound is the symbol of fear, terror or an urgent appeal for the calf to get to safety. Panting is also used by the rhinos, particularly when they are facing danger and inviting other rhinos to join up. The speed and pattern of this panting are one of the communicating weapons by conveying different messages to the others (Mayer, 2012). A complex and varying system of breathing is too sent as signals to the others by rhinoceroses. A mother rhinoceros often calls to her infant with breathing pants when she becomes separated (Reed, 2017). Behaviour biologists have been able to decode different sound signals produced by rhinoceros, such as snorts signifies anger, huffs are meant for greetings and squeaks often means surprise and confusion (www.lionworldtravel.com,2020). Rhino's silent call, probably a pre-mating whispering call made by a female Sumatran rhino, below 20 hertz, recorded by Elizabeth Von Muggenthaler in San Diego Zoo which is considered to be an infra-sound and a rarity in the biological world (Baskin,1992). A similar low-frequency contact call (rumble) was also recorded in African savannah elephants who are known to be highly social and exhibit a complex vocal communication system (Baotic *et.al.*, 2018).

Scent marking by dung deposition and urination: Olfactory communication is certainly advantageous, as the receiver is allowed to assess certain parameters of its social environment very specifically (Roberts,2007). A tremendous advantage of using chemical signal instead of the visual and auditory signal is that chemical traces persist for some period of time (Eisenberg and Kleiman, 1972). Many mammals make use of scent-marking, sometimes possible to help defend territory, but probably with a range of functions both within and between species (Gosling, 1990), (Gosling and Roberts, 2001). According to the scent fence hypothesis, scent marks are like a fence around the periphery of the territory to keep intruders out (Hediger, 1949; Sun & Müller-Schwarze, 1998). In rhinos, the marking by scent is used mainly for two reasons, either for searching of mates, a sexual partner in particular or for defending its territory. Though Indian rhinos are not much territorial but in the dry season, the dominant bulls become slightly territorial for occupying the best areas. The rhino heavily depends on its power of olfaction quite extensively, since it is so finely tuned. The largest part of the brain is its olfactory area, indicating how important it is to the animal (Meyer, 2012). A spectacular and interesting eventful behaviour occur in rhinoceros that they use some common latrines during the course of their movements in their familiar areas where they inhabit. This animal is of special interest for their defecation and scent marking behaviour which is also common in some megaherbivores like equids, tapirs, elephants, antelopes and south American camelids (Lucas, E. Fiorelli *et.al.*, 2013).

It is assumed that the sight (Ullrich, 1964), scent (Srivastava, 2015) or both of the previously deposited dung and dung piles stimulate them to defecate. Sometimes the released odour of the fresh dung leads them to move towards those dunging areas following the right tracks and direction. This uncommon behaviour, i.e., the common sharing of the same dung pile with a selection of defecation spots are thought to have some deep

relations for exhibiting the self-existence to other individuals. Besides scent marking of territories, dung and dung piles are reported to indicate the reproductive state of the individuals also. The displays of bulls during defecation and urination depend on their social rank (Owen-Smith, 1975).

In the latter part of my study I mainly concentrated on the sequential and chronological successive depositions (Bhattacharya, 1994) done by the individuals to find out if they used any kind of remote sensing technique or if, at all, they were involved in any kind of intimate scent-marking relationships.

Table 1: Sequence of depositions by different individuals forming dung piles (Sample size = 104) [Bhattacharya, 1994]

SEQUENCE OF DEPOSITIONS BY INDIVIDUALS

Number	of	dung	piles				
1	2	3	4	5	6	7	
A♀	← A♂						40
A♂	← A♀						19
A♀	← A♂	← A♀	← A♂				12
A♀	← A♂	← I♀					11
I♀	← I♀	← I♂					07
M-C	← M-C	← M-C					05
A♂	← I♂	← A♀					03
I♀	← A♂	← A♀	← A♂ (Fig.1)				02
I♀	← A♀	← A♂	← I♀				02
A♂	← A♀	← I♀	← I♂				02
A♀	← A♂	← A♀	← A♀	← A♂	← A♀	← I♂ (Fig.2)	01

Sequential depositions by different individuals and scent marking relationship: After Judging from the varying diameters of dung balls of different defecations in one midden (dung pile) it was clear that the dung piles were not made by a single animal or by the animals of a particular age class, but by different individuals of different age groups. Of the 104 dung piles at Gorumara, track and footprint analysis clearly indicated that in 40 cases (almost 38.5%) two breeding pairs used to defecate in different parts of the park in October-November-December, where cows were the first defecators. In 19 cases (only 18.26%), the bulls first defecated and latter the cows defecated over the dung of the bulls. In five occasions, one mother-calf association was seen to defecate over their own dung (Table: 1). Fig.1 and Fig.2 show the duration and sequential formation of dung piles by individuals known by their footprints. Dung piles were used by Indian rhinos of all age and sex classes at Chitawan National Park, Nepal (Laurie, 1978) and similar findings have been reported in case of white rhinos where the dung piles appeared to have a territorial marking function (Owen-Smith, 1971).

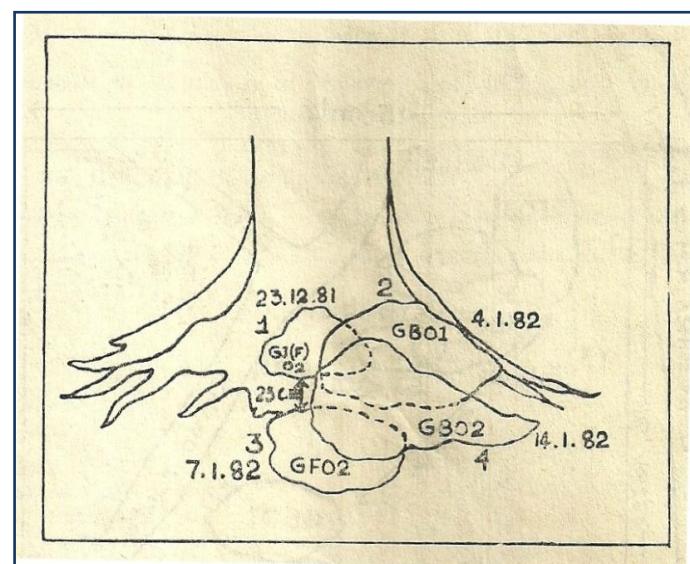


Fig.1 A sketch done on the work book during field study at Gorumara showing the sequential depositions of known

individuals over the base of the buttress of a shimal (*Bombax ceiba*) tree (after Bhattacharya, 1994)

Buechner *et.al.* (1975) reported that a captive male Indian rhino had a tendency to squirt urinate at the junction of his shade and outer enclosure. In recent years many works on scent-marking behaviour have been done on South African white rhinoceros. Like Indian rhinos, white rhinos are also fond of smelling each other's crap. They use communal defecation sites to communicate and, moreover, one interesting thing about white rhino midden-making behaviour is that every rhino of every age class in the area do use the same dung heap, but the resident dominant male is the only one who defecates right in the very centre of the pile (Shields, 2017). Bull rhinos also squirt urinate on trees or bushes as a way to communicate their presence, often spraying a single bush or tree as many as four times (Reed, 2017). A study done on white rhinos' dung proves that it contains status updates, with the faeces' odour broadcasting chemical signals about a rhino's age and sex, and about whether females are in the oestrous condition (reproductive state) or if males are out of territory (Weisberger, 2017) or even how long ago they were there (Shields, 2017).

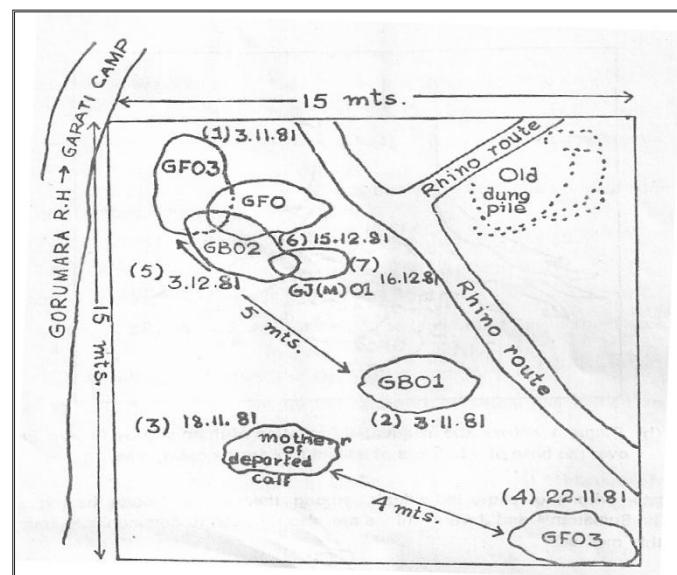


Fig.2 Another sketch during field study showing the sequential depositions made by rhinos of different age and sex classes beside well frequented rhino route at Gorumara. (Bhattacharya, 1994)

The spraying of urine and making middens are, therefore, common means of communicating with other rhinos to establish ownership of personal territory or the presence of another rhino at a watering hole or popular feeding area. The rhino uses these scents to identify itself to the others. The rhino generally sprays two or three sprays in quick successions after approximately every five minutes, (Meyer, 2012). Communication through urine is well known in many animal species, with males frequently spraying urine to mark their territories and establish dominance (Weisberger, 2017).

Do the Indian rhinos follow any chemical clues by sniffing dung-piles? In several occasions, the rhinos at Jaldapara and Gorumara were observed sniffing the dung piles. But, what they used to understand by sniffing were unknown at that time. Latter on some chemical experiments of different individuals' dung have been done by some workers. A new study on white rhino dung has proved that chemical clues in white rhino faeces provide information about age, sex, general health, and reproductive status to other rhinos that visit the communal

latrine. The scientists then analyzed the chemical makeup of the rhinos' dung. They found that faeces of various ages and sexes—such as young animals, dominant males, and females in oestrous—carry different chemical cues (Arnold, 2017).

It has been further analysed by the minute differences in the odours emitted from the dung of free-ranging white rhinos and found that 2,3-dimethylundecane is signalled for an individual's sex, heptanal decoded age class, nonane defined male territorial status and 2,6-dimethylundecane indicated females' oestrous state (Marneweck and Jürgens, 2017). In addition to that, they came to the conclusion that males exhibited behaviours associated with the specific odours, e.g. territorial male is equivalent to potential threat and reduced latency in assuming vigilance; oestrous female signifies potential mate which leads to an increased investigation. These results indicate that the signals identified from the dung of free-ranging individuals do transmit key information (Marneweck *et.al.*, 2018). This reaction shows that the male rhinos were gathering information from chemicals in the dung.

In another observation it has been seen that the white rhinos consume roughly a minute by sniffing dung piles of strangers while they spend only 20 seconds to sniff over faeces of familiar rhinos (Wardlow, 2014). It was also pointed out that rhinos excreting chemical cues are unique to each individual (Wardlow, 2014). That means each individual is recognised by its communicable dung odour. According to a new study, rhinos use shared defecation areas to leave dispatches that can be "read" by all the other rhinos in their social group (Weisberger, 2017).

Associated Pre and Post Defecating Behaviours:

Change of tracks: Analysis of the trails revealed that in most cases rhinos just stopped on their path and dropped dung. Usually, the rhinos stopped near the old dung or dung piles and defecated either close to the previous one or a few metres away or over the old dung/dung piles. In five occasions at Gorumara and four occasions at Jaldapara changing of tracks for defecation were noticed mostly by the adults (Table 2). Probably they might be influenced by the scent of previously deposited dung piles lying on widely separated parallel tracks.

Earth scrapping over the own dung: Rhinos normally walked off immediately after defecation. But on eight occasions, two adults, one at Gorumara (the largest and oldest bull, GB01) and another at Jaldapara; and in two cases one known immature male at Jaldapara left the mark of scrapping the earth backwards over their own dung by both the hind feet alternately (Table 2). With those scrappings, the earth usually covered their droppings partially. In case of the largest bull (GB01) at Gorumara it was observed that this earth scrapping behaviour developed at the onset of the dry season only after a fight with his close rival GB02 for occupying the best area for water, cover and green grass. In that fight, the former (GB01) was the loser. It might be a fact that the particular bull tried to hide the odour emitted from his freshly deposited dung as well as hiding himself from that of his dominant rival. Although the Indian rhinos have pedal scent gland, the dusting over their dung might have partial success for hiding themselves. Part of their dung balls was damaged with those scrapings. Mud and leaves were cast off about one and a half metre away behind the dung piles.

Dung scrapping: An opposite dung scraping behaviour was also noticed from the signs left by them. In both the National Parks two dominant adult bulls, GB02 and JB02 were mainly the dung scrappers (Table 2). It was probably meant to exhibit

themselves to their close rivals and subordinates. One mother and her calf were evidenced to scrap their own dung at Gorumara due to some unknown reason, possibly the calf imitated its mother

Dung scrapping behaviour is somewhat rare in Javan (Hoogerwerf,1970) and Sumatran (Borner,1979) rhinoceros. It was, however, reported that though dung scraping behaviour is rare in Greater one-horned rhinoceros at Royal Chitawan National Park in Nepal, all the age and sex classes were involved in dung scrapping (Laurie,1978). This behaviour is known to be frequent in African black (Klingel and Klingel,1966) and white rhinoceros (Sperka,2013). In case of White rhinoceros the dominant male is also the only one that kicks his dung around afterwards, spreading his smell around the midden, but also carrying the smell of his dung with him everywhere he walks (Shields, 2017). Before leaving, the white rhino is careful to kick all of the dung off of their feet, discarding the smell of the other animals (Meyer, 2012). On the contrary, according to the observation of Reed (2017), bull white rhinos kick the contents of the midden to get the scent on their feet before moving on.

Foot-dragging: The foot-dragging marks made after defecation is also an important behaviour to be mentioned here. In both the National Parks, two adults and two immature were involved in foot-dragging behaviour after defecation. The oldest bull (GB01) of Gorumara left the mark of foot-dragging on two occasions. In both the cases, small fresh dung fragments were found up to a certain distance along with the foot-dragging marks (Table 2). The probable cause of foot-dragging might be due to the fact that, the bull was trying to clean his dung laden feet just to get rid of the releasing odour from his hind feet because he was trying to avoid his close rival GB02 after losing a battle by him a few days back (Bhattacharya,1994). In other cases, foot-dragging marks were devoid of dung fragments. Why the immature drag their feet for any reason requires further investigation. Male white rhinos are often seen dragging their feet after defecation. Usually, they do it to mark their territory either by destroying plants or by dragging feet (www.whiterhinofacts.com 2018).

Table 2. Some associated Pre and Post Defecating behaviours exhibited by rhinos in two National Parks (Bhattacharya,1994).

Associated behaviours	Gorumara	Jaldapara
Change of tracks for defecation	A♀ (GF02)-1 A♀ (GF03)-2 A♂ (JB02)-2	A♂ (JB01)-1 A♀ (JF03)-1 Imm. (NS)-2
Earth scrapping over own dung	A♂ (GB01)-4	A?-4 Imm.♂(JJM02)-2
Dung Scrappig	A♂ (GB02)-3 A♀ (GF01)-1 C (GC01)-1 Imm. (NS)-1	A♂ (JB02)-2 A♀ (JF03)-1 Imm. (NS)-1
Foot dragging	A♂ (GB01)-2 Imm.♀ (GJF02)-2	A (NS) - 3
Coprophagy	Nil	Probably by an immature

NS = Non sexed, Imm. = Immature, GF = Gorumara Female, GB = Gorumara Bull, GC = Gorumara calf. GJF = Gorumara Juvenile Female, JF = Jaldapara Female, JB = Jaldapara Bull, JJM = Jaldapara Juvenile Male.

Coprophagy: The coprophagy nature is found to be very insignificant in Indian rhinos but it is best reported in African black rhinoceros (Klingel and Klingel,1966). During the two

years of our study at Gorumara no case of coprophagy was noticed. At Jaldapara, it was done probably by an immature since the foot impressions of that individual were distorted owing to muddy soil and it was difficult to prove its exact recognition, but, the overall size, at a glance, was favourable for its inclusion in the younger age class. This behaviour was confirmed since no signs of adding fresh defecation and other post defecating behaviours like, earth scrapping, dung scrapping, foot-dragging etc. left there and the dung fragments remained scattered close by. The rhinoceros may be stimulated for this kind of behaviour due to a shortage of minerals in their body.

Pedal scent gland: The rhinos followed each other by sniffing along the tracks, since pedal scent gland occurs in them. Pedal scent glands, common in Artiodactyla, are shown to be confined to the genus Rhinoceros among Perissodactyla (Cave, 2009). It is likely that olfactory signals include odours left on the trails from those glands in addition to those of urine and dung. The pedal scent gland in rhinoceros may have been evolved because of the scent of dung on the feet quickly disappears in a wet environment. So, there may have been a selection pressure for scent marking by evolving the pedal scent gland as an alternative form. It was proved to be an easier way to locate and communicate with fellow individuals despite living a solitary nature. The Sumatran (Strickland, 1967) and Javan (Sody,1959) rhinos are also reported to communicate among themselves with this method.

Scent marking behaviour: Great one-horned rhinos have the habit to maintain, males in particular, somewhat loosely defined territories and in doing so, they take the help of their own defecated dung or spraying urine. They have frequently seen dung scraping, foot-dragging, earth scraping over their own dung etc. and each of this kind of behaviours have a specific meaning. Obviously, when any rhino scrap earth over its own freshly deposited dung, that does mean that he or she wants to conceal himself/herself from the nearest rival. On the contrary, dung scraping behaviour is a type of exhibition of the presence of an individual, so that the scent of dung is sprayed in the air, thereby, exhibiting the vigour of the dung scrapper. The foot-dragging behaviour is also associated with the getting rid of dung which is stick to their hind feet while kicking dung backwards after defecation adds scent to their path.

Comparatively, females are less territorial and can accommodate other rhinos irrespective of age and sex in their areas, or in other words, they often have overlapping territories which they frequently change with the change of season (Bhattacharya, unpubl. data) and that also depends on the availability of food and water. Females, particularly in oestrous condition, are also equally capable to communicate with the males and they are also to send signals by spraying urine or by scraping dung or by dragging feet so that fellow individuals can feel their presence. Though they possess pedal scent gland under their feet, but in the wet environment that becomes less effective and they rely more on their urination and dung deposition.

Actually, as the rhinos of all age and sex classes defecate communally, the dung piles probably act as information centres. If someone thinks that the rhinos are just scrapping and kicking its own dung around, he or she is mistaken, rather, the rhinos, particularly the adult bulls, are adding important information to the dung heap. The adult white rhino bulls often show dominance by dung scrapping (Sperka,2013). In the case of South African white rhino, Sperka(2013) wrote his observation-

“Females in the area by will leave their droppings, but they will not scrape. They leave a scent message for the dominant bull in case they are ready to mate. If that is the case he will pick up the info at his next visit and look for the lady. Any young bull pathing through the territory will also leave his message (a distance away from the big guys' stuff) without scraping to tell the dominant bull that he does not want to challenge him. If another bull puts his dung on top or near the dominant bull's droppings and scrapes them around then he declares his intention to challenge the territory holder. As soon as they meet they will fight!

So, if you see dung in the bush, it is not always just waste”

Apart from the strong odour of fresh dung, the Indian rhinos are able to smell the remote faint ones since they have a very high power of sensing smell rather than vision. Often the males are observed walking with their heads to the ground as if sniffing, presumably following the scent of females (Dinerstein,2003).

Scent marking behaviour can be used as rhino conservation and translocation: Scent related animal behaviour, rhino, in particular, can open up a new avenue for a promising new opportunity in future research. The hidden chemical signs may be much useful in their conservation strategies like encouraging breeding programmes between isolated groups to promote genetic diversity (Weisberger, 2017). Captive breeding programmes may also get benefit from the stimulation of the power of rhinos' smell. (Marneweck, *et.al.*, 2017). The researchers now believe that the unnoticeable chemical signals in the middens can broadcast messages connected to mating and territorial supremacy.

Other communication types:

Body Language: These are the visual or touch signals used by rhinos for communication purposes. However, because of their poor eyesight, body language is the least important way for communication in Indian rhinos. These can be listed as below:

a) Visual signals:

- i Rhinoceroses can communicate extensively with one another, especially the bulls can show aggression by flattening their ears and flaring nostrils to warn another animal.
- ii The bulls can show aggression by bashing their heads into bushes.
- iii Erection of ears and tails is considered to be a signal of curiosity.
- iv Calves may swing their heads to invite the conspecifics to play with them.

b) Touch signals:

- i A sign of affection is shown by rubbing sides with another rhino.
- ii The breeding pair may overlap their neck regions as a pre-mating signal.

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References

- [1] Arnold,C. (2017): Rhinos Use Poop Piles Like a Social Network. <https://www.nationalgeographic.com/news/2017/01/rhinoceroses-poop-middens-communication/>
- [2] Baotic,A.,Garcia,M.,Boeckle,M.andStoeger,A.(2018): Field Propagation Experiment of Male African Savannah Elephant Rumbles: A Focus on the Transmission of Formant Frequencies, Animals 2018, 8(10), 167
- [3] Baskin,Y.(1992): The Rhino's silent call, Discover, Newsletter, April1,1992.
- [4] Bioexpedition (2013): Rhinoceros Behaviour, bioexpedition.com,June,26,2013.
- [5] Bhattacharya,A and Acharya,S.(1993): Identification of great Indian one horned rhinoceros (R.unicornis) by foot impression. Proc.Zool.Soc.,Vol.46(2), pp. 125-130.
- [6] Bhattacharya,A.(1994): Some new aspects of pre and post defecation behaviour associated with scent marking relationship in Great Indian one horned rhinoceros Cheetal, vol.XXXIII, no.3-4 pp. 1-9.
- [7] Bhattacharya,A. and Chakraborty, K. (2016a): Defecation Behaviour of Great Indian one horned Rhinoceros (Rhinoceros unicornis,L), IJSR (ISSN 2319-7064), Vol.5, Issue 7 pp 923- 928
- [8] Bhattacharya, A. (2020): Ecology, Behaviour and Management Practices of Great Indian one horned Rhinoceros (Rhinoceros unicornis, L.) at Gorumara, Jaldapara and Kaziranga National Parks, India. Ph.D. thesis, Raiganj University, 202 pages.
- [9] Borner,M.(1979): A Field Study of Sumatran Rhinoceros., Ph.D. Thesis, University of Basel, pp.169.
- [10] Buechner,H.K., Mackler,S.F., Troman,H.R. and Xenten,W.A.(1975): Internationl. Zoo Yearb., 15:160-165.
- [11] Cave,A.J.E. (2009): The pedal scent glands in Rhinoceros, Journal of Zoology 139(4):685 - 690 .August,2009
- [12] Dinerstein, E. (2003): The Return of the Unicorns: The Natural History and Conservation of the Greater One-Horned Rhinoceros. New York: Columbia University Press. ISBN 0-231-08450-1
- [13] Einsty.com (2019): Ten facts about Indian Rhinoceros, April 18,2019
- [14] Eisenberg,J.F. and Kleiman, D.G.(1972): Olfactory Communication in Mammals, Annual Review of Ecology, Evolution and Systematics, Vol.3 (1): 32 pages.
- [15] Gosling, L.M. (1990): Scent Marking by Resource Holders: Alternative Mechanisms for Advertising the Costs of Competition. Chapter IV in “Chemical Signals in Vertebrates 5” Ed. Macdonald, D.W., Müller-Schwarze, D. And Natynczuk, S.E. Oxford University Press, Pages 315-328.
- [16] Gosling, and Roberts,S.C. (2001): Scent-marking by male mammals: Cheat-proof signals to competitors and mates, Advances in the Study of Behaviour, Elsevier, Vol.30, pages 169-217
- [17] Hediger, H. (1949): Säugetier – Territorien and ihre Markierung. Bijdr. Dierkd.,
- [18] Hoogerwerf, A. (1970). Udjung Kulon The Land Of The Last Javan Rhinoceros. Leiden: E.J. Brill., 28: 172-184.
- [19] <https://www.lionworldtravel.com/news/who-knew-10-incredible-facts-about-rhinos> (2020)

[20] Klingel,H. And Klingel,U. (1966): The rhinoceros of Ngorongoro Crater., *Oryx*, Vol.VIII, No.5, pp.302-306.

[21] Laurie,W.A. (1978): The ecology and behaviour of greater one horned rhinoceros., Selwyn College, Cambridge, Ph.D. thesis, 450 pp.

[22] Lucas E. Fiorelli, Martín D. Ezcurra, E. Martín Hechenleitner, Eloisa Argañaraz, Jeremías R. A. Taborda, M. Jimena Trottelyn, M. Belén von Bacsko & Julia B. Desojo (2013): The oldest known communal latrines provide evidence of gregarism in Triassic megaherbivores *Scientific Reports* volume 3, Article number: 3348 (2013)

[23] Marneweck,C., Jürgens,A., Dung odours signal sex, age, territorial and oestrous state in white rhinos (2017): *Proceedings of the Royal Society Biological Sciences*, Pages 8

[24] Marneweck, C., Jürgens, A. and Shreder, A. M. (2018): The role of middens in white rhino olfactory communication, *Animal Behaviour*, volume 140, pages 7-18

[25] Meyer,A.(2012):Rhino Communication <https://www.rhinosinfo.com/rhino-communication.html>

[26] Muggenthaler,E.V., Stoughton,J.W. and Daniel,J.C. (2000): Infrasound from the Rhinocerotidae,

[27] Owen-Smith(1971): *Nature*, 231: 294-296

[28] Owen-Smith, N. (1975): The Social Ethology of the White Rhinoceros *Ceratotherium simum* (Burchell 1817*), *Zeitschrift für Tierpsychologie*, Wiley Library

[29] Reed,C (2017):HOW DO RHINOS COMMUNICATE? <https://animals.mom.me/how-do-rhinos-communicate-5150427>

[30] Roberts,S.C. (2007): Scent Marking, The University Press of Chicago, U.S.

[31] Shields, J (2017): White Rhinos Communicate via Massive Communal Poop Piles, <https://animals.howstuffworks.com/mammals/weird-poop-habits-white-rhino.htm>

[32] Sody,H.J.V.(1959): Das Javanische nashorn, *Rhinoceros sondaicus*, historisch and biologisch. *Zeitschrift fur Saugetierkunde* 24(3/4): pp. 109-240, figs. 1-13.

[33] Sperka,C (2013): Rhino Communication Centre, Johhannesberg, South Africa

[34] Srivastava,V.(2015): *Unicornis in Peril*, *Science Reporter*, March,2015.

[35] Strickland, D. (1967): Ecology of the rhinoceros in Malay. *Malay.Nat.J.* 20: 1-17

[36] Sun, L. and Müller-Schwarze, D. (1998): Beaver response to recurrent alien scent: Scent fence or scent match? *Anim. Behav.* 55:1529–1536.

[37] Ullrich,W.(1964): Zur Biologie der panzernashorner in Assam., *Zool.Gart.,Lp.*, Vol.28; pp225-250.

[38] Wardlow, T. (2014): White Rhinos: It's All About the Poo, <https://fightforrhinos.com/tag/communication/>

[39] Weisberger, M. (2017): Rhinos' Communal Toilets Are Poo-Powered Social Networks, *Proceedings of the Royal Society Biological Sciences*, Pages 5. www.whiterhinofacts.com (2020)

[40]