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Defecation Behaviour of Great Indian One Horned Rhinoceros (*Rhinoceros unicornis*,Linn.)

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Abstract: ***Great Indian one horned rhinoceros, a large perissodactlyle herbivore, has a peculiar habit of sharing common latrines and thereby, making large dung heaps. This behaviour may have some scent marking relationships among the individuals. Almost 83% initially deposited single defecations latter turned into dung heaps. Preferable locations of dunging areas were usually on or beside the well frequented rhino routes which were more than 86% of all the dunging areas. Among the physical parameters the average size of the complete dung heap is nearly 3 meters and height attains 55 cm (approx.). The span of formation of a complete dung hill is usually 55 days and takes on average 7 droppings. Interestingly, the number of dung balls decreases as the age increases. The estimated dry undigested parts are also less in calves measuring 11.6% but adults were found to contain as high as 14.28% as they are to take less nutritious coarse grasses. On the other hand moisture content is high in calves, almost 82%. In both these cases the sub adults lie in between these two age classes.***

Keywords: defecation, dung hill, dung pile, dung heap, midden, depositions, dunging area, rhino route

1. Introduction

Greater one horned rhinoceros (*Rhinoceros unicornis* L.*)* is a grotesque looking, semi-aquatic, large perissodactyle herbivore, now only confined in Nepal and sub Himalayan northern and north-eastern states of India. Their main home land is tall reeds and grass lands and often they are seen to spend times in swamps and riversides. In adult condition they weigh between 1800 kg to 2700 kg. And they consume 1% on average of their body weight daily (F.V.Houwald, 2016). This animal is of special interest for their defecation and scent marking behaviour which are also common in some mega herbivores like equids, tapirs, elephants, antelopes and south American camelids (Lucas, E. Fiorelli et. al., 2013). Indian rhino has a tendency to defecate in some selected locations (for some days or even months), and as a result of continuous deposition of dung at the same spots, leads to a heap like structures (Bhattacharya, A., 1994 and Hazarika B.C. & Saikia P.K., 2010). 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). 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 selection of defecation spots is thought to have some deep relations for exhibiting the self-existence to other individuals.

Here, this study mainly concentrates on the clustering patterns of dung piles and selection of defecation spots according to their choice which may have some scent marking relationships among the individuals. Besides, some physical parameters like, measurements of dung heaps, wet and dry weight, dry weight of undigested plant materials according to their age classes were also studied.

2. Study Areas

During the years 1981 and ’82 an extensive study was undertaken on different aspects of defecation behaviour of Indian rhinoceros at Gorumara (26°40′ N, 89°00′ E) and Jaldapara (25°68′ N, 89°55′ E) National Parks (the then Wildlife Sanctuaries) under the foot hills of eastern sub-Himalayan region. It was a part of a broader field study on the ecology and behaviour of this animal. They are located in the northern part of the state West Bengal in the district Jalpaiguri (Jaldapara is now located in the district Alipurduar). Gorumara lies at the confluence of Murti and Jaldhaka rivers, on the other hand, Jaldapara is situated on the flood plain of river Torsa. Gorumara is supported by a good buffer zone, whereas, southern part of Jaldapara has got a shape like a trouser owing to the rapid encroachment by the villagers and outsiders (most of them are refugees, displaced from the erstwhile East Pakistan, latter from Bangladesh), resulting a very long boundary, leaving almost no buffer zone.

Apart from core zone Gorumara is predominated by sal (*Shorea robusta*) forest in the buffer zone. Most of the areas of Jaldapara are occupied by mixed riverine forest consisting of sissoo (*Dalbergia sissoo*), sirish (*Albizzia lebbek*), khoir (*Acacia catechu*) etc. intermingled by grassland meadows. Nearest Airport is Bagdogra for Gorumara and Coochbehar for Jaldapara. Nearest rail stations are Chalsa and Hasimara for Gorumara and Jaldapara respectively

3. Methods

Since little direct observation on defecating posture was possible and which was a chance factor also, mainly the tracks and other traces (like dung scrapings and foot dragging with dung particles etc.) of rhinos near the dung

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piles were taken into consideration and were noted. Day, time, month, seasons were also recorded to analyse the seasonal variation. The individual identifications were mostly based on the size and peculiarities of their hind foot prints (Bhattacharya and Acharya, 1993). Those foot prints, which one was whose foot print, gradually became familiar to us during the previous few months effort. A ready reference of life sized known foot prints were carried together with other instruments. After recording those foot prints, close to the freshly deposited dung, were rubbed off afterwards to avoid repeatations. Sometimes, the rhinos present near fresh depositions were considered as the depositions made by those same individuals. All the middens (dung heaps) were recorded on a number of working maps differentiating it into chronological depositions with a citation of date, time, season etc. Frequent visits to different defecation sites, either near the mud pools, or in their grazing areas or at the sides of their routes made us possible to get acquainted with on spot identifications of those places on a map.

At first all kinds of depositions were noted and were classified either as dung piles or single defecations. Dung piles were specifically defined as groups of single defecations attached with one another end to end or overlapped considerably, or the single defecations not more than 5 meters away from one another at their nearest ends. Latter on those gaps might have a chance to be filled up by a number of single defecations. Besides this, the measurement and weight of the dung balls were also taken into account as the identifying characters of the different age classes. However, individual identifications were not possible by measuring the dung balls. The freshness and the number of depositions were noted just to find out how many weeks or months were taken actually to form a complete midden. The number of dung balls per deposition and the total weight of single fresh depositions were also recorded to find out the gross assimilation efficiency (not discussed in this article). The dry weight of each 50 gm dung sample of twenty different single defecations /dung piles were measured to examine the actual content exhaled from the body. Each defecation spot was marked, numbered and labelled with twigs and photographs were taken by an Ashahi Pentax ME camera (lens 1:1.4) for further analysis while away from the field.

4. Results and Discussions

Clustering patterns and locations

Altogether 276 depositions were recorded in the study areas in three years duration (from August, 1980 to July, 1983) to know about the cluster patterns as well the locations of defecations. The recorded defecations were either single or in the form of dung piles (Table 1). The large dung piles were found to be located beside well frequented rhino routes both at Gorumara and Jaldapara (Table2). The further analysis reveals that the rhinos tended to defecate more at dung piles than on new spots. Ullrich (1964) reported that sights of dung piles stimulate them to defecate. Odour of the dung piles is also one of the principal cause to provoke other rhinos to defecate on or near the spots (Srivastava, 2015). Single defecation sites were mostly developed into dung piles if they were deposited on or beside well frequented rhino routes. Single defecation sites comprised of only 17% (Table 1), while, on the other hand, the cluster occurrence of deposits comprising of two and three defecations were more than 50% of all the defecations recorded. Very large and scattered dung piles consisting of seven or eight defecations were rarely seen during that period. It might be due to the low population densities in those areas. Approximately 2/3rd of the single defecations were deposited on or beside less frequented rhino routes where they visited occasionally. However, very large dung piles were frequently observed latter on at Kaziranga because of higher rhino density/km^2 over there.

Table 1: Single or cluster occurrence of depositions in the study areas (sample size = 276)

Single/cluster of dungs	*Occurrence*	*Percent of occurrence*
1 single	47	17.0
2 cluster	80	28.9
3 cluster	74	26.8
4 cluster	43	15.6
5 cluster	21	7.6
6 cluster	7	2.5
7 cluster	2	0.7
8 cluster	2	0.7

The successive depositions on the dung piles varied according to the frequency of visits to those areas made by the rhinos. Many sites consisting of single and double defecations left unused for several months but had been observed to be of use again when some rhinos moved into those areas in search of food and water. So the clustering patterns of defecations largely depended on the availability of food, water and mud pools whose existences were variable throughout the season. In April and May (peak dry, hot season), 1982 at Gorumara, 34 dung heaps (among 60 dung heaps) comprising of 3, 4 and 5 defecations were found to be concentrated near the marshes, narrow streams, water and mud pools. Many of those piles were newly formed. At Gorumara and Jaldapara, the unburnt areas of grassland in October-November, 1981-1982 and 1982-1983, rarely had fresh depositions added to the dung piles. But in the following seasons, i.e., after 3-4 months, most of the old dung piles began to be added again by fresh depositions. Some were newly created during or just after the period of burning and re-growth of grasses. Burnings were usually followed by the rains and thunderstorms which simultaneously added nutrients to the soil in the form of burnt ash for facilitating re-growth of young green succulent grasses. This biological change of fodder drew attraction to the rhinos of all age and sex classes.

It is obvious from the above observations that during hot months rhinos had a tendency to concentrate in those temporary best areas making overlapping home ranges (Bhattacharya and Pal,1982). The dominant ones often engaged themselves in intra and inter specific battle for keeping supremacy over those best comfortable areas, having watery mud pools, which underwent gradual shrinkage both in volume and area. These all behaviours led them to defecate more frequently in those so called best areas.

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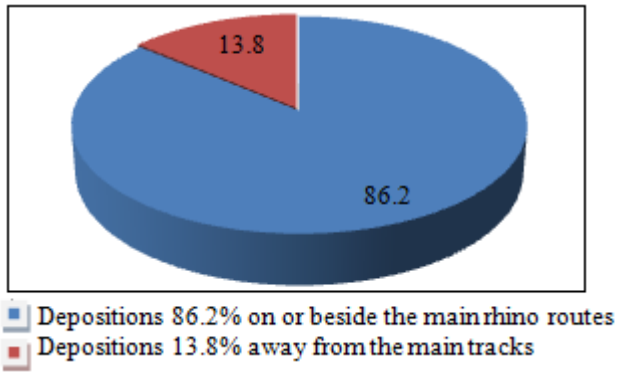
Rhinos tended to select particular spots to defecate either in presence or in the absence of dung pile. The locations are shown in Table 2. Dung piles were concentrated mostly on or beside the main rhino routes. A considerable number of defecations were found at the ecotonal zones like, at the junction between grassland and woody mixed forest; and at the base of the tree trunks (Table 2).

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. Sumatran rhinos had a preference for depositing their faeces on main tracks or close to the streams (Borner, 1979) which is similar to the present observation. For convenience, the locations were divided into two major divisions, i) On or close to the main tracks and ii) away from the main tracks. Dung piles deposited away from the main tracks were found to be comprised of only 13.8% among all the defecations. It has been reported by certain workers that in captive conditions rhinos preferred to defecate on certain locations (Skafte, 1961).

Table 2: Details of the locations of dung piles (sample size 276)

Locations	Preferred places	Occurrence	% of occurrence
A.On or close to the main tracks	1.Deposited on or beside rhino path	128	46.4
	2. Beside water pool and marshes	65	23.6
	3. At the base of the tree trunks	31	11.2
	4. On small herbs dry litters and grasses(under open sky)	7	2.5
	5. On small grass/dry and wet litters(under canopy)	5	1.8
	6. On coarse gravels (under open sky)	2	0.7
		238	86.2
B.Away from main tracks	1.On clear soil, sand, grass in grassland	38	13.8
TOTAL		276	100.0



Sketch 1: Locations of defecations

Physical Characteristics of dungs

Altogether 36 single defecations and 21 dung piles were taken into consideration to have a knowledge on the dunging area, its height, no of droppings taken to form a dung pile, and the span of period of its formation (Table 3). However, it was difficult to know about the dropping numbers and the duration of formation for the deserted as well as the disintegrated dung piles since the entire dung piles became brittle and individual droppings became intermingled with one another. These were all found in an area of 3 km^2 at Gorumara consisting of tall grasses, ecotones, short and medium grasses, sal and mixed forest. The result reveals that a complete dung pile occupied nearly 255 cm in diameter and 55 cm in height in average which were much more wider and higher than those of the deserted dung piles, i.e., 170 cm in diameter and 30 cm in height. The dung piles varied in the degree of piling up and some were scattered over a wide area. In those cases dung scrapings might be the cause of scattering. The maximum height of one dung pile recorded was 70 cm but many piles were under 40 cm at their highest peaks.

A dung pile, usually, took about 55 days to give its complete shape and on average took 7 droppings to build up before using another defecation spot elsewhere (Table 3a). A fresh single defecation occupied 55cm in diameter and 16 cm in height, whereas, old lone defecation took only 45 cm and 13 cm in diameter and height respectively (Table 3b).

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Table 3a: Physical characteristics of defecations and span of formation

Types of Dung pile	No. of samples	Diameter (in cm)	Height (in cm)	No of droppings taken	Span of use (days)
Complete Dung pile	21	295.3	54.6	7	55
Deserted Dung pile (going to be Disintegrated)	16	170.0	26.0	?	?

In general the fresh defecations had a range of greenish black to deep greenish brown in colour. The texture seemed to have more or less spongy and moist. As the fresh defecations grew older the texture would become soft and brittle, dry and the colour gradually turned into straw colour. In many cases the size of the dung balls appeared to remain same, at least externally, for up to four months. Then gradually the dung balls broke up into pieces and ultimately the entire dung turned into a brittle fibrous mass which finally disintegrated. The Indian Rhino is categorized under 'bulk and roughage feeder' as it has the capacity of extensive lower tract fermentation and with its typical setting of teeth pattern, mouth anatomy and volume of intake (Lahan et.al.,1993). With additional rumen/reticulum volume of 53% and 22% more than other ruminants, it requires a microbial synthesis of food intake for almost 20 hours and a caecum digestion for around 3 hours. Thatswhy, a fresh adult dung does not look like a ruminant dung but contains fibrous material from digested leaves, grasses, remains of reeds, small branches and twigs of maximum up to 5 cm in length which gave the dung its typical rough texture and appearance. The dung of adult Sumatran rhinos appeared to be coarser than those of the immature (Hubback,1939). . The Indian Rhino is basically a grazer, the short grassland being its prominent food habitat. Due to adverse shrinking in habitat, the animal is forced to take a considerable amount of browse material (Lahan et.al.,1993)

The dung of adult, sub adult and calf consisted the diameter of the dung balls of 13.8 cm (±1.1 cm), 9.9 cm (±0.6 cm) and 5.2 cm (±0.5 cm) respectively (sketch.2). The adult animals deposited 5 to 10 dung balls at a time and the calves deposited as many as 14 dung balls on average at a time (Sketch 2). The range of the number of dung balls noted was 5-10, 9-12 and 12-16 respectively. It is to be concluded that the dung balls varied inversely with the age of the rhinos, i.e.

$$NDB \propto \mathbf{1/a}$$

Where 'NDB' is number of dung balls and 'a' is the age. Sex found to have no effect on the number and size of the dung balls.

Table 3b: Physical characteristics of a single defection

Type of dung (adult)	No. of samples	Diameter (in cm)	Height (in cm)	Texture	Colour
Fresh	58	55	20	spongy & moist	greenish black to deep greenish brown
Old	35	45	13	soft, brittle and dry	straw coloured

Weight analysis, dry weight and moisture content of dung:

Seventy eight fresh single droppings were considered for weight analysis in that study period. The average weight of a single defecation in a bout by adults, sub adults and calves were 10.953 kg, 4.946 kg and 1.689 kg respectively (Table 4). The dry weight and the weight of dry undigested part

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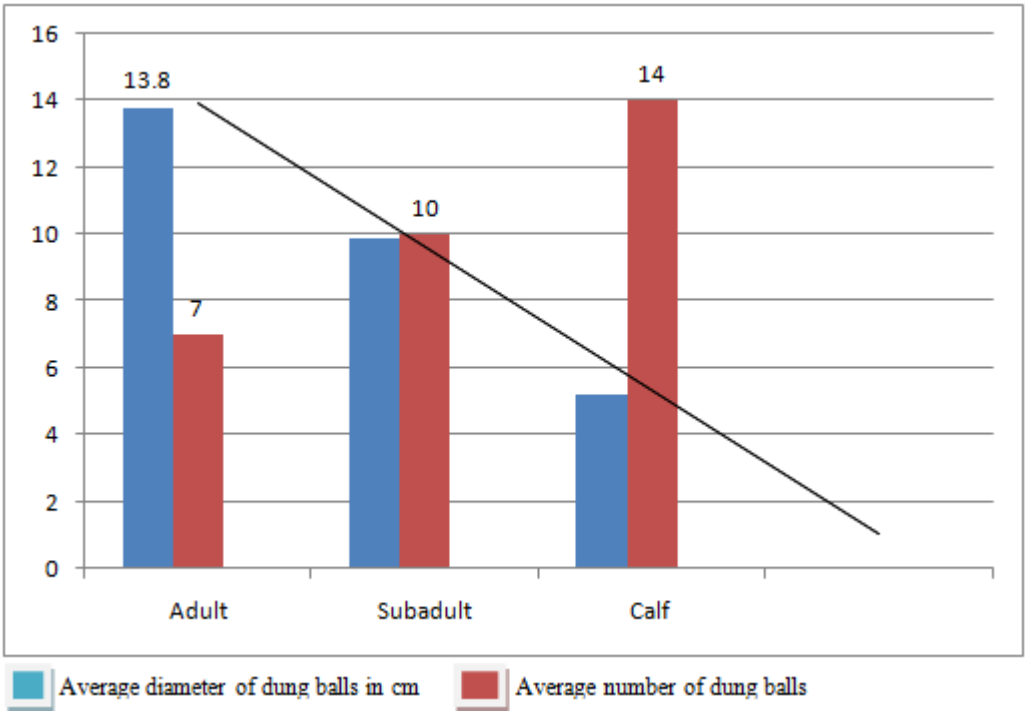

Sketch 2: Chart showing a correlation between diameter and number of dung balls in different age classes

From 50 gm dung samples of each of 20 individuals' defecations for all the age . Classes were measured in the laboratory in 1981-1982. All the fresh dung samples were collected from Gorumara and they were kept in airtight polythene packets so that the moisture content would remain intact. Afterwards 50 gm

Table 4: Weight analysis of 78 fresh single defecations according to age class

Age Class	Sample Size	Average wt. of total single Defecation
Adult	40	10.953 kg
Sub adult	20	4.946 kg
Calf	18	1.689 kg

dung samples were transferred in to the packets made up of blotting paper for each age class. The packets were labelled with proper age class, time and place. Then all the blotting paper packets were kept inside a hot oven at a fixed temperature of 39^0C and left in the oven for 48 hrs. After proper drying the packets were taken out and the dry weights of the dung samples were measured. After that the dry materials were meshed in a 2 mm perforated mesh and the materials remained left on the mesh were considered as the dry undigested part.

The Table 5 shows that the dry weight from each 50 gm dung sample for adult, sub adult and calf comprises 19.3%, 18.7% and 17.6% respectively; on the other hand, the moisture content comprises 80.7%, 81.3% and 82.32% respectively. A gentle gradual decrease of moisture content is observed as the age increases. The above data correspond with that of the general appearance of dung where the usual texture of the dung balls of the calves are comparatively smoother due to absence of coarse and larger undigested particles.

Weight analysis, dry weight and moisture content of dung

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Table 5: Measurement of dry weight, dry weight of undigested part and moisture content from 50 gm fresh dung sample for each age class (Sample no. 20 from each age class).

ADULT		SUB ADULT		CALF	
Dry weight in gm	Dry undigested part in gm	Dry weight in gm	Dry undigested part in gm	Dry weight in gm	Dry undigested in gm
$\Sigma X = 193.3$ $\bar{X} = 9.7$ $\bar{X}\% = 19.3$	$\Sigma Y = 142.8$ $\bar{y} = 7.14$ $\bar{Y}\% = 14.28$	$\Sigma X = 186.9$ $\bar{X} = 9.34$ $\bar{X}\% = 18.69$	$\Sigma Y = 131.0$ $\bar{y} = 6.5$ $\bar{Y}\% = 13.0$	$\Sigma X = 176.2$ $\bar{X} = 8.81$ $\bar{X}\% = 17.62$	$\Sigma Y = 115.8$ $\bar{y} = 5.79$ $\bar{Y}\% = 11.6$
$\bar{X} - \bar{Y} = 2.525$ gm		$\bar{X} - \bar{Y} = 2.84$ gm		$\bar{X} - \bar{Y} = 3.02$ gm	
Moisture content		Moisture content		Moisture content	
$C - \bar{X} = 40.33$ gm i.e., $50 - 9.7 = 40.33$ gm $(C - \bar{X})\% = 80.7\%$		$C - \bar{X} = 40.65$ gm i.e., $50 - 9.34 = 40.65$ gm $(C - \bar{X})\% = 81.31\%$		$C - \bar{X} = 41.19$ gm i.e., $50 - 8.81 = 41.19$ gm $(C - \bar{X})\% = 82.32\%$	

The gradual decrease of weight in dry undigested part from adult to calf is also taken into account which has been shown in Table 5. The average dry undigested part is 7.14 gm (14.3%, approx.), 6.5 gm (13.0%) and 5.79 gm (11.6%) from each 50 gm dung sample for adult, sub adult and calf respectively.

The above results reveal that the adults can consume all kinds of grasses irrespective of their nutrient contents. For this reason the appearance of their dung is rough textured; on the other hand, the calves were highly selective in taking their fodders (Bhattacharya, 1993). The calves took mostly soft tip portions of lush green grasses or juicy food plants of higher nutrient contents. The sub adults' (not reached to reproductive state) food selection lie in between these two age classes and they are not such selective as the calves do. It was observed that the milking calves sometimes used to take coarse grasses just to imitate their accompanied mothers, but in quick succession they used to reject those coarse grasses and started searching for softer ones.

5. Conclusion

In most of the cases the adult females were the initiator to form a dung pile anew (Laurie, 1978 and 1982; Bhattacharya,1994). But when the formation of a dung pile reached to its momentum, individuals of many more age and sex classes were found to be involved to form it completely. Milking calves were always with their respective mothers. The weaning calves sometimes associated sometimes departed. From the above results it is resolved that the spot selection on or beside the main rhino routes proved to be the first choice for their deposition. The deserted dung piles again found to be reused in some occasions.
It seems to be one kind of communicating system where the odour of the large dung heaps keeps them communicated. This sharing of common latrines is a peculiar habit of large herbivores which is inherited from the prehistoric mega herbivores (Fiorelli et.al.,2013).

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