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A Preliminary Study of Dung Decay in the Yala National Park, Sri Lanka

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Introduction

Assessing seasonal and geographic variation in dung densities can provide information on the temporal and spatial patterns of habitat use by elephants. Enumeration of dung densities also allows the calculation of elephant densities, provided the dung decay rate and the defecation rate can be estimated, and is one of the recommended techniques for elephant census (Dawson & Dekker 1992; Kangwana 1996). Dung decay rates may vary widely between seasons and habitats, and are required to be estimated concurrent with such studies. A study in Cameroon in which 870 dung piles were monitored *in situ* found that dung lasted 75 to 147 days on average depen-ding on the month the dung was produced (Nchanji & Plumptre 2001). Similar studies monitoring 1282 dung piles in Gabon (White 1995) and 426 dung piles in Ghana (Barnes *et al.* 1997) also found that rainfall, humidity and diet had major impacts on dung decay.

During a dung density study in the Yala National Park, we found wide variation in dung densities in different habitats and seasons. Therefore, we conducted a pilot dung decay rate study to assess the variation involved, in order to evaluate the need for and to design a detailed dung decay rate experiment to be conducted subsequently.

Methods

The Yala National Park is located in south-eastern Sri Lanka. The mean annual rainfall in the area is 750-1000 mm with a distinct wet and dry season (Survey Department 1988). Most rainfall occurs from October to January during the Northeast monsoon (>100 mm/month), and a few inter monsoonal showers occur from February to April (50-100 mm/month). The drought is intense from May to September. The study sites chosen were along the coastal strip of Yala and were approximately within 500 m of the sea. The vegetation in that area consisted of coastal scrub forest, dominated by thorny shrubs and interspersed with trees about 10 m high.

We collected a total of 144 individual dung boli estimated to be less than 12 hours old, from the vicinity of water holes and placed them at four different locations. At each location, 12 dung boli were placed on day zero (10th July 2006) and another 12 boli each added on days 2 and 4, making a total of 36 boli per location. Two locations (B and D) were inundated by the December 2004 tsu-nami and the other two (A and C) were not.

Boli (Fig. 1) were placed 5 m apart from each other on a line running from West to East (A, B and C) or South to North (D). Each bolus position was marked with a ribbon attached to the closest tree branch. The GPS position, cover (sun or shade), substrate type (earth, leaves, and/or plants), substrate moisture (wet or dry) and microhabitat (tree, shrub or open area) was recorded for each bolus at placement.

The experimental boli were visited at six day intervals, noting the amount of bolus remaining; if it was entire or broken up; presence of termites and if any part of the bolus was turned into earth by them; the presence and number of plants, mushrooms, and insects other than termites. A bolus was deemed to have 'disappeared' when it could not be clearly discerned from a standing position two meters away. From 24th January 2007 on, when only 11 boli were left (aged 194 to 198 days) the visit frequency was reduced to every 12 days. The study was terminated on 13th March 2007 when the remaining boli were 242 to 246 days old.

Table 1. Details of surroundings of the 144 boli.

Location		A	B	C	D	Total
Cover	Sun	18	29	29	32	108
	Shade	18	7	7	4	36
Substrate*	Earth	25	24	24	13	86
	Leaves	19	11	16	8	54
	Plants	0	9	2	25	36
Micro-habitat	Tree	15	7	7	3	32
	Shrub	19	6	13	7	45
	Open	2	23	16	26	67

* more than one can apply for a bolus

ANOVA and t-tests were conducted to assess the presence of significant variation in decay rate between locations and other environmental variables.

Results

Environmental parameters

Most (75%) boli were in the sun and location A had the highest proportion (50%) of boli in shade (Table 1). The microhabitat for 22% of boli was 'tree', 31% 'bush' and the remaining 46% 'open area'. Locations B and D had mostly 'open area', C had 'shrub' and 'open area', and D 'tree' and 'shrub'. The substrate of 60% of the boli was earth, 38% leaves and 25% plants (grass and herbs). The most common substrate in locations A, B and C was earth, and in location D plants (Table 1).

Most boli (85%) broke up and decayed gradually. Only 8 boli decayed very rapidly, ie. recorded as 'entire' on one visit and 'disappeared' the next. A total of 26 boli (18%) were covered by growth of surrounding plants and were recorded as 'disappeared'. Two boli were washed away by rain and one submerged.

Most boli (94%) had insects other than termites on them at some stage. Ants were observed on 43% and termites on 40% of the boli. Even if termites were not directly observed, most boli (84%) had signs of termite activity such as being turned into earth. On average the first termite activity was noted after 15 ± 29 days.

Figure 1. One of the study boli.

Mushrooms grew on 41% of boli and it took on average 112 ± 20 days for their first appearance. Germination of seedlings was noted on 22% of boli and it took on average 122 ± 21 days before the first seedling was observed. Wood apple (*Limonia acidissima*) was the commonest plant observed and was noted sprouting on 15 boli.

Time of disappearance

On average a bolus disappeared after 112 ± 51 days (Fig. 2). However, 8 boli were still present when the study ended after 246 days. As the time of disappearance for these 8 boli was not known they were excluded from the analysis. A gradual decay and disappearance of dung was noted over the first 100 days and a more rapid phase of decay over the next 50 days (Fig. 3).

Disappearance time varied significantly between locations (Table 2). Boli lying in the sun were found to last significantly longer than those in the shade (Table 2). Significant differences were observed between the 3 microhabitat types; tree, shrub and open area (Table 2). No significant difference in dung decay rate was found between areas affected and not-affected by the tsunami (Table 2) and termites were not a significant cause of decay (Table 2).

On average it took 122 and 112 days for the first plants and mushrooms respectively to sprout on a bolus. Boli with plants or mushrooms disappeared significantly later than those on which nothing grew (Table 2).

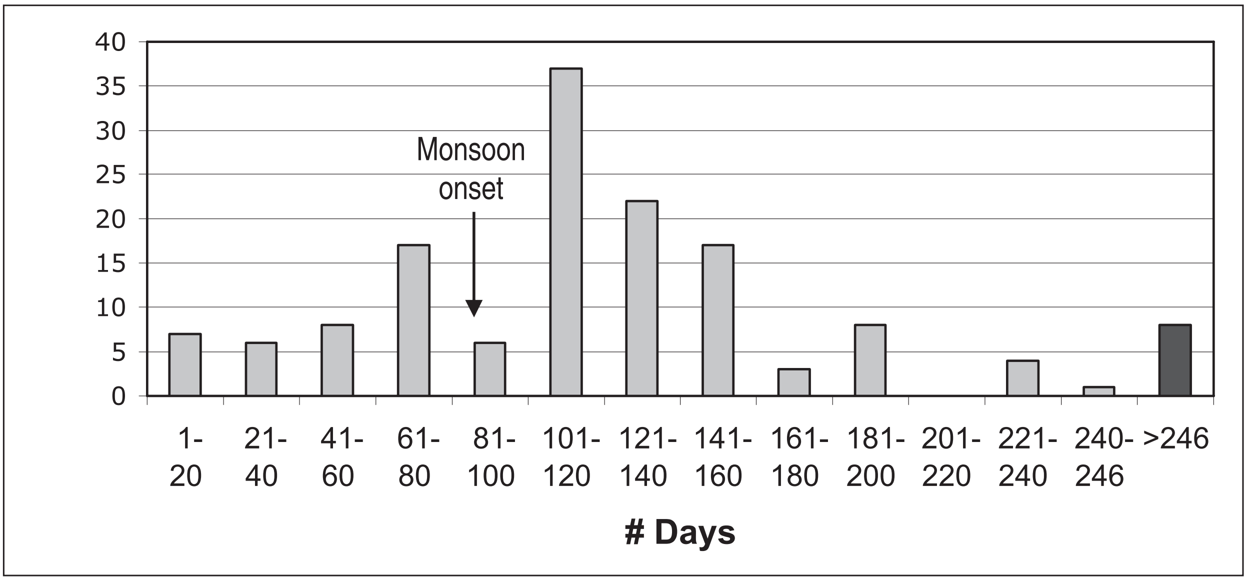

Figure 2. Histogram of the number of days it took for the 144 boli to disappear.

Discussion

The significant differences in decay rates observed between locations can be attributed to environmental factors. Exposure to sun was the most important determinant of decay rate, most likely due to the drying and hardening of the dung, leading to decreased bacterial activity and greater resistance to decay by physical factors.

Although most boli were colonized by termites, no significant difference in decay was observed due to them. In many cases, dung boli were converted to earth casts by termites, which tended to persist. Therefore, establishing a strict definition of what a termite cast is, and when a bolus so affected is deemed to no longer represent a dung bolus but 'disappeared' is important in dung decay rate and density studies.

A significant corelation between the age of dung and the presence of plants and mushrooms was noted. However, here the age of dung is the cause rather than the effect as both plants and mushrooms appeared after a period of a few months.

This study was set up in July, in the middle of the dry season, with brief rains occurring once in August and twice in September. The monsoon rains started on 13th October, at which time the dung in the study was 91 to 95 days old. The highest number of boli disappeared between 101 to 120 days (Fig. 2), likely related to the onset of rain.

Table 2. Average dung decay time and tests for significance of different variables.

Type	Group	N	Mean [days]	P
Location	A	34	67.3	0.0000 [A]
	B	34	129.6	
	C	32	147.9	
	D	36	106.0	
Tsunami	No	66	106.4	0.2090 [t]
	Yes	70	117.5	
Cover	Sun	102	119.6	0.0024 [t]
	Shade	34	89.5	
Micro-habitat	Tree	30	94.3	0.0092 [A]
	Shrub	42	104.4	
	Open	64	125.5	
Termites	Yes	117	111.6	0.7941 [t]
	No	19	114.9	
Plants	Yes	27	165.1	0.0000 [t]
	No	109	99.0	
Mush-rooms	Yes	51	153.1	0.0000 [t]
	No	85	87.5	

[A] = ANOVA; [t] = t-Test

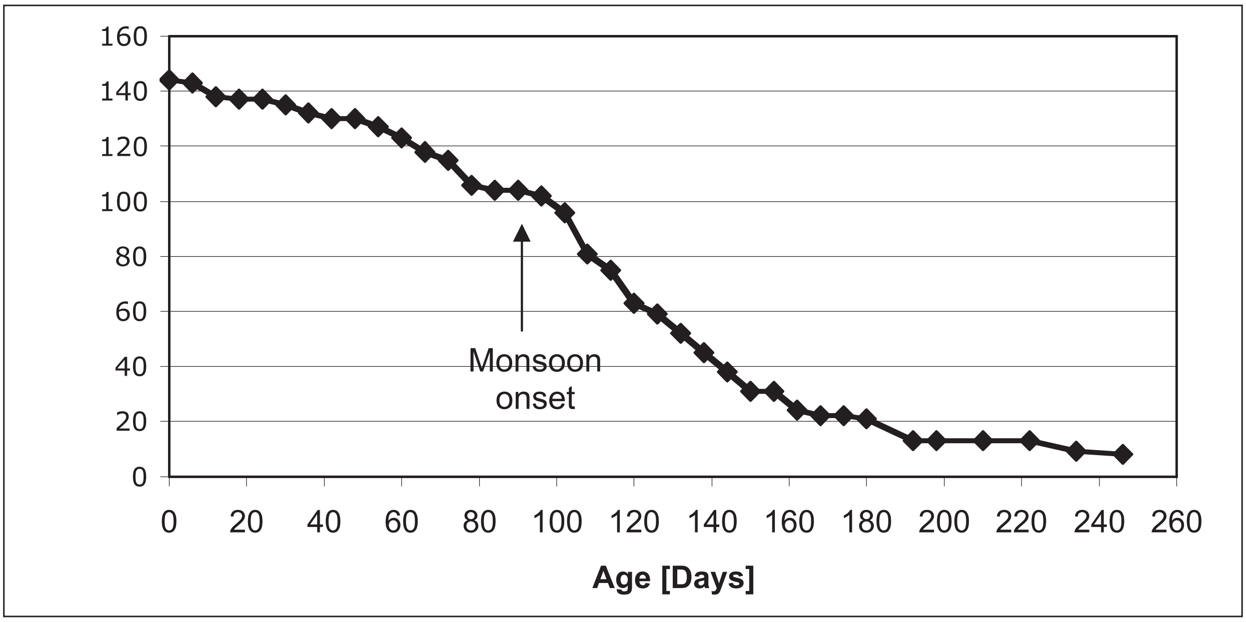

Figure 3. Graph showing the survival for the 144 dung boli over time.

Dung may be directly affected by rain, but more importantly, moisture may increase the activity of microbes, insects and other causative factors of decay. As the age of dung in our experiment was only 6 days apart, we could not discriminate between the affect of rain and age related factors of decay. However, our results suggest that rain is a major determinant of decay rates as observed in African studies (White 1995; Barnes *et al.* 1997; Nchanji & Plumptre 2001). Since the mean time of sprouting for plants and mushrooms were 122 and 112 days respectively, environmental changes consequent to rainfall are likely to have been the main cause of their appearance.

Our pilot study suggests that environmental variables have a significant influence on decay rates and that there maybe considerable variation in decay rates even within a particular habitat. Therefore, the need for a comprehensive dung decay study with replicates within and between habitats and seasons is supported.

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