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# NOTES BRÈVES

## SEED EATING IN ELEPHANT DUNG BY TWO LARGE MAMMALS IN THE CONGO REPUBLIC

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### RÉSUMÉ

Au Congo, dans une clairière forestière visitée par de nombreux éléphants, des sitatungas appartenant à un groupe résident et des potamochères issus de trois groupes visiteurs fouillent régulièrement les crottins d'éléphants pour y prélever des graines. Ce comportement représente 33% des activités alimentaires des potamochères et 20% de celles des sitatungas. Ces graines constituent une source alimentaire significative et l'affouragement dans les crottins semble un comportement répandu dans la région. Cette prédation de graines après dispersion n'a pas d'effet sur la régénération forestière car les crottins d'éléphants sont déposés dans des zones où les graines ne germent pas en raison de l'hydromorphie et du piétinement du sol. Lorsque les éléphants déposent leurs crottins dans des clairières marécageuses, ils ne peuvent être considérés comme des disperseurs efficaces de graines.

### SUMMARY

In a Congolese forest clearing visited regularly by a number of elephants, a resident group of sitatungas and three visiting groups of red river hogs were observed to forage on elephant dung for seeds. This accounted for 33% of feeding time in hogs and 20% in sitatungas. Seeds taken from elephant dung constitute a significant food resource and foraging in dung seems to be a widespread phenomenon in the region. This post-dispersal seed predation has no effect on forest regeneration because in clearings elephant dung are deposited where seeds do not germinate due to the soil hydromorphy and trampling. When dung are deposited in swamp clearings, elephants cannot be considered as efficient seed dispersers.

### INTRODUCTION

In the Republic of Congo-Brazzaville as well as the Central African Republic, forest elephants (*Loxodonta africana cyclotis* Matchie, 1900) are known to visit regularly forest clearings, where they spend most of their time pumping out and drinking mineral-rich water in small streams and waterholes (Turkalo & Fay, 1995; Quérouil *et al.*, 1999; Magliocca, 2000). North of the Parc National d'Odzala (PNO)

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in Congo, one hundred natural clearings are distributed over a 1 500 km<sup>2</sup> area and are visited regularly by large mammals including elephants (Vanleeuwe *et al.*, 1998). At the Maya Nord clearing, elephants are present on average 7 out of 8 days and daily visits include a mean number of 34 elephants (Quérouil *et al.*, 1999; Magliocca, 2000). During the night, up to one hundred individuals may congregate there. In the morning, numerous fresh dung piles can be found mainly in streams and on their banks. Two of the five large mammals which visit the clearing in addition to elephants, the sitatunga (*Tragelaphus spekei* Sclater, 1864) and the red river hog (*Potamochoerus porcus* Linnaeus, 1758), were observed to forage in fresh elephant dung. In this paper, we describe their behavior, the amount of time they spent foraging in dung, and the kind of food eaten. Then, we discuss the relative importance of this feeding behavior for the two mammal populations and comment on this post seed-dispersal predation.

## MATERIAL AND METHODS

### STUDIED SPECIES

*Tragelaphus spekei gratus* has a large distribution area centered on the Congo Basin. This forest species mainly inhabits swampy areas and may enter clearings and gallery forests where permanent water is available. It is known to eat leaves, herbaceous vegetation and seeds and to possess a nycthemeral activity rhythm (Malbrant & MacLachy, 1949; Magliocca *et al.*, 2002). *Potamochoerus p. porcus* is present in dense forests and gallery forests of Western and Central Africa and is also observed in bordering savannas. It has an omnivorous diet that includes fruit and seeds, tubers, roots and animal prey collected by night and day (Malbrant & MacLachy, 1949; Ghiglieri *et al.*, 1982; Kingdon, 1982; Magliocca, 2000). Adult males of both species may weigh up to 80 kg. Sitatungas females weigh 40 kg on average and females hogs, 45-55 kg (Malbrant & MacLachy, 1949; Manning, 1983).

### STUDY SITE

The Maya Nord clearing is located North of the PNO (01° 08' N-15° 00' E). It averages 20 ha and is covered by herbaceous vegetation dominated by Cyperaceae (12 species out of the 45 identified) and Gramineae (5 species) which is seasonally flooded. It is surrounded by dense primary forests and Marantaceae forests. It is crossed by several streams forming two waterholes where elephants gather and pump muddy water out (Magliocca *et al.*, 1999).

### STUDY METHODS

Observations were made from a 4-meter high platform located at the edge of the clearing from October 1996 to June 1997 and in August-September 1998. Observations lasted for a total of 132 days and 1 434 hours during which we recorded all the changes in the number of animals present at the clearing. Respectively

1 434 and 404 hours of direct observation were obtained for sitatungas and hogs. Time spent feeding at the clearing was recorded using scan sampling. Records were made every 15 min, for 45 full-days (6 a.m.- 5 p.m.; n = 495 h) for sitatungas and 31 days (n = 190 h) for hogs. Three feeding activities were recognized: feeding on herbaceous vegetation, foraging in elephant dung and suckling.

## RESULTS

### TOTAL TIME-SPENT AT THE CLEARING AND TIME-SPENT FEEDING

A single group of sitatungas was permanently present at the clearing during the day. Its size varied from 16 to 24 animals. A few animals sometimes went into the forest after sunset. In addition, from the end of January to the beginning of March, at least one of the two adult males was absent from the clearing on 80% of the observation days. Three identified groups of hogs (including 2, 3 and 7 animals respectively) and some unrecognized individuals visited the clearing on 58% of the observation days. The mean duration of their daily visits was 5 h 30 (range: 2 min- 11 h).

At the clearing, sitatungas spent 27% of their time feeding (n = 8 698 records; Table I): feeding on herbaceous vegetation accounted for 79% of their feeding activities and foraging in elephant dung for 20%. Adult females spent more time feeding than adult males and young (0-10 months; 29.4 vs. 25.6 and 22.8% respectively;  $\chi^2_{df2} = 60$ ,  $p < 0.001$ ). However, adult males spent significantly more time foraging in dung than females and young (53.5% vs. 18.4 and 14.0%;  $\chi^2_{df2} = 467$ ,  $p < 0.001$ ). Unweaned young about 2 months old were seen digging in dung. On average, seed-eating bouts lasted 70 min, 33 min, and 18 min per day for males, females and young respectively.

TABLE I

*Distribution of different feeding activities in sitatungas and hogs.*  
( ): Number of individuals.

	HOGS		SITATUNGAS		
	all individuals (12)	total group (16-24)	adult males (1-2)	ad. + sub-ad. females (9-13)	young (3-8)
time spent feeding % (n records)	52.7% (654)	27.0% (8 698)	25.6% (587)	29.4% (5 286)	22.8% (2 542)
feeding on herbaceous vegetation, %	66.8	79.3	46.5	81.6	81.6
foraging in dung, %	33.2	19.6	53.5	18.4	14.0
suckling, %	0	1.1	0	0	4.4

At the clearing, hogs spent 53% of their day- time feeding (n = 654 records), including 67% foraging in herbaceous vegetation, eating herbs and digging the soil for roots, tubers and possibly animal prey, and 33% foraging in elephant dungs (Table I). Their presence during the night cannot be ascertained.

#### DUNG FORAGING AND KINDS OF FOOD EATEN

Early in the morning, sitatungas and hogs dug fresh elephant dung in a systematic manner. Both species searched primarily in dung piles deposited in streams rather than in those found on stream banks (75% and 88% vs. 25% and 12% respectively). However, whereas sitatungas could immerse their heads and necks to reach seeds in deep water holes, hogs always foraged in shallow streams and only immersed their snouts. Both species used their snouts to dig the dung and select nuts and seeds (Fig. 1). Hogs also used their fore-legs to rid seeds of dung fibers before eating them. Both species selected large seeds and avoided fibrous material in which small seeds and insects were embedded.



Figure 1. — An adult female *Tragelaphus spekei gratus*, with her son, digging elephant dung deposited in a stream.

Fresh dung disintegrated quickly in water and only the heaviest items piled up while most of fibers were carried away. Three main plant species were identified in these deposits: *Panda oleosa* nuts (Pandaceae), *Strombosia pustulata* nuts (Olacaceae) and *Strychnos camptoneura* seeds (Loganiaceae). *Panda* fruits are 5-7 cm

globular drupes with fibrous flesh surrounding a hard woody kernel embedding 4 to 5 seeds. Their nuts were the most frequent items in dung. *Strombosia* fruits are olive-like drupes (2 × 1 cm) including one seed protected by a kernel (2 mm thick). The fruits of *Strychnos* lianas are ca. 10 cm in diameter. A thick mesocarp surrounds many unprotected flat seeds, about 2 cm in length, embedded in soft pulp. Nuts as well as seeds were found uncrushed in elephant dung. Sitatungas and hogs crushed *Strombosia* nuts and *Strychnos* seeds, while only hogs crushed *Panda* nuts.

## DISCUSSION

Hogs spent about 1 hour per visiting day foraging in elephant dung. Taking into account the rate of presence of hogs at the clearing, during the day, the three identified group spent respectively 5 h 30 min, 1 h and 30 min per month on average eating seeds. Their presence during the night was not asserted. Sitatungas spent 1 hour every day foraging for seeds, amounting to 30 h per month; they were not observed to feed on seeds during the night. Consequently, seeds collected in elephant dung can be considered to be a significant food source. Seeds are known to be a highly energetic food and especially to be richer in lipids than herbaceous vegetation. *Panda* seeds contain 10.6% fatty acids, 14% sugars and 3% proteins and *Strombosia* seeds 6.5%, 7.5% and 8% respectively (Sourd & Gautier-Hion, 1986). As only herbaceous vegetation growing in the clearing is available for the group of resident sitatungas, seeds probably present a useful nutritional supplement which could explain the quasi-permanent presence of the group at the clearing.

Seeds of both *Strombosia* and *Panda* are well protected against consumers; only immature seeds of *Strombosia* with soft kernels are known to be eaten by some species of ruminants and primates, whereas *Panda* nuts are only collected by rodents and elephants (Gautier-Hion *et al.*, 1980, 1985; Lieberman *et al.*, 1987; White *et al.*, 1993). It is likely that the passage through the elephant digestive track softens seed shells and facilitates breaking the nuts. Moreover, a stay in water could also tenderize nuts and seed shells. However, the fact that both sitatungas and hogs systematically searched for fresh dung in the morning suggests that these foods are not eaten after a long period in water. *Panda* nuts remain unavailable for sitatungas as they cannot crack them open whereas the dentition of hogs, especially their molars, is strong enough to crack them open (Ghiglieri *et al.*, 1982). Furthermore, the fact that sitatunga adult males, which are about twice as heavy as females, spend more than twice as much time digging dung, suggests that smaller animals found seeds difficult to eat, especially *Strombosia* nuts.

Seeds in elephant dung did not appear to be a limiting food source. Both *Strombosia* trees and *Strychnos* lianas were abundant in the surrounding forest and up to 20 trees and 17 lianas were seen fruiting simultaneously along 14.6 km transects (Magliocca, 2000). Only one *Panda* tree was found fruiting along the same transects, and the predominance of their nuts in elephant piles suggested that they were carried over long distances. Their accumulation was locally so large that the nut layer could be several tens of centimeters deep over tens of square meters, and the stream which links the two water holes was almost completely embedded with nuts. No feeding competition was observed between the two consumers, possibly because sitatungas, which are able to immerse their necks in deep waterholes, had access to a food niche out of reach of hogs, and because the latter are the only consumers of *Panda* nuts.

The large quantity of diaspores brought to the Maya Nord clearing by elephants has no chance to germinate due to the soil hydromorphy and trampling and no tree saplings were observed during the cartography of the clearing vegetation (Magliocca, 2000). Thus the post-dispersal seed predation by hogs and situngas has no effect on forest regeneration. Eating seeds out of elephant dung could be a wide-spread strategy. Situngas and hogs were observed on most of the 36 clearings explored in the region (Vanleeuwe *et al.*, 1998). Furthermore, these mammals can also feed on seeds laid in dung piles along elephant paths, as do *Cercocebus galeritus* and several duikers (Ekondzo & Gautier-Hion, 1998; D. Ekondzo pers. comm.). In Uganda, Struhsaker (in Ghiglieri *et al.*, 1982) observed the tracks of bush pigs that seemed to follow elephants in order to take *Balanites wilsoniana* seeds rejected in their dung. In Gabon, hogs were opportunistically observed to dig elephant dung for insects and seeds (White, 1995).

Therefore, elephants routinely visiting clearings did not always act as efficient seed dispersers as described by many authors (e.g. Alexandre, 1978; Lieberman *et al.*, 1987; Western, 1989; White *et al.*, 1993; Yumoto & Maruhashi, 1995). This is especially the case of *Panda oleosa*, a species for which elephants are considered as the only disperser (e.g. Alexandre, 1978; Lieberman *et al.*, 1987; Feer, 1995) but of which a huge amount of seeds rotten in the rivers.

The extent to which elephant dung provides food for primary consumers has to be more documented, as well as the impact, on forest regeneration, of the quality of seed dispersal by elephants.

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