

Leaf-swallowing in Nigerian chimpanzees: evidence for assumed self-medication

Andrew Fowler · Yianna Koutsioni · Volker Sommer

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Abstract A field study in Gashaka, Nigeria, adds the fourth subspecies of chimpanzee, *Pan troglodytes vellerosus*, to the list of African ape populations in which leaf-swallowing occurs. Unchewed herbaceous leaves of *Desmodium gangeticum* (Leguminosae-Papilionoideae) were recovered in 4% of 299 faecal samples of wild chimpanzees and clumps of sharp-edged grass leaves in 2%. The ingestion is believed to serve self-medicatory purposes because the leaves had a rough surface or were sharp-edged (which could be related to parasite control through a self-induced increase of gut motility), were not chewed, were excreted whole (indicating that they were not ingested for nutritional purposes), leaf-swallowing was restricted to the rainy season (during which time parasite re-infections are more common), and parasitic worms (*Oesophagostomum stephanostomum*) were found together with the leaves.

Keywords *Pan troglodytes vellerosus* · Self-medication · Leaf-swallowing

Introduction

Self-medication through ingestion or topical application of non-nutritional substances such as plant secondary compounds, bark or soil is believed to occur in

a variety of animal taxa, including bears, cattle, birds and primates (review in Rodriguez and Wrangham 1993; Huffman 1997, 2001). Studies of African apes in particular provide evidence for situation-specific ingestion of plants for assumed medicinal purposes, such as (1) infrequent intake of species which are not a regular part of the diet, (2) a habit of ingestion (fold leaves; swallow unchewed) that prevents any nutritional benefit, (3) plant use is associated with periods of a high risk of parasite infection, (4) illness or infection at the time of ingestion, (5) apparently healthy conspecifics show no interest in the plant and (6) a positive change in condition after ingestion. So far, a total of more than 34 different plant species at 13 study sites in Africa have been recorded to be situation-specifically ingested by apes (Huffman 1997, 2001).

A well-established example for assumed self-medication in apes is leaf-swallowing, e.g., of plants of the genus *Aspilia* (Compositae; Wrangham and Nishida 1983). Leaves are typically swallowed in the morning, i.e., on a relatively empty stomach, they are folded with the tongue and palate to ease swallowing, they are not chewed, are excreted undigested, and the peak of consumption occurs during the rainy season.

Medicinal benefits of leaf-swallowing were originally associated with pharmacological antiparasitic properties, such that phytochemicals decrease the ability of worms to attach to the mucosal lining of the intestines and/or that chemotaxis attracts worms into the folds of leaves (review in Huffman 1997). However, many different plant taxa are now known to be swallowed, rendering it unlikely that they all have similar chemical properties. Instead, these plants appear to have a consistent physical property, i.e., the rough surface of the leaves sports many hooked and spiky hairs. It had

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A. Fowler (✉) · Y. Koutsioni · V. Sommer
Department of Anthropology, University College London,
Gower Street, London WC1E 6BT, UK
e-mail: a.fowler@ucl.ac.uk

therefore been assumed that worms became attached to the bristly surface as if to “velcro” and that the coarse structure may also have functioned as a rasping plug, dislodging parasites from the intestines (review in Huffman 1997).

However, the current view of the parasite expulsion mechanism of leaf-swallowing does not focus on the physical trapping of worms. Instead, material that is not digested well may trigger a purging response of the gastro-intestinal tract by rapidly inducing diarrhea. This decreases gut transit time, causes worm expulsion and interrupts the life cycle of parasites (Huffman and Caton 2001). A similar mechanism might explain occurrences of undigested grass in the faeces of such diverse taxa as birds, carnivores and primates; sedge grass (Cyperacea) in particular can be high in fibre, sharp edged and coarse (review in Huffmann 1997).

Amongst African apes, self-medication is assumed to occur in eastern lowland gorillas, bonobos and three subspecies of chimpanzee in Central Africa, West Africa and East Africa (Huffman 1997, 2001). A fourth subspecies—*Pan troglodytes vellerosus* from eastern Nigeria and western Cameroon—has only recently been recognized. While genetically the most distinct (Gagneux et al. 2001), they are also the most endangered (Kormos et al. 2003). We report on likely self-medicationary behaviour in *P. t. vellerosus*, thus widening the list of ape populations available for cross-population comparisons.

Methods

Gashaka Gumti National Park lies in eastern Nigeria. The southern (Gashaka) sector has rugged terrain and harbours a great diversity of wildlife, including five species of monkeys as well as a sizeable chimpanzee population. Our major study site is at Kwano (583 m; 07°19'N–011°35'E), 11 km from the village of Gashaka. The climate fluctuates half-yearly between a dry and a wet season (annual rainfall 1,670–2,337 mm). The area is located in the sub-Saharan Guinea zone and borders the Cameroonian highland forests, representing a mosaic of habitats including woodland, lowland and gallery forest, and montane forests above 1,500 m (Chapman and Chapman 2002). The dominant ethnic groups are Fulani cattle herders and Hausa-speaking farmers. A database on ethno-botany in the region is based on a compilation of unpublished reports and interviews with local people from January–March 2003 (Koutsioni 2003).

The chimpanzees of Gashaka–Kwano have been studied by the “Gashaka Primate Project” since 2000.

The apes have frequently been encountered directly, although continuous follows are not possible. Party size averaged 3.7 (range 1–17) animals and nest-group size 5.7 (range, 1–23; Sommer et al. 2004). Faecal samples are regularly found under freshly deserted night nests.

Results

Undigested leaves were found on seven occasions in fresh chimpanzee faeces collected from beneath night nests (Table 1). Of 12 individual samples, 4 contained only folded herbaceous leaves, whereas 8 contained both folded herbaceous leaves (up to 25) and grassy leaves or clumps of grass (Fig. 1). The samples were from unidentified individuals, but the varying weight of the bolus (mean, 101 g; range, 29–193 g) suggests that leaf-swallowing was not restricted to a certain age–sex class. At least one sample was diarrhetic.

Between April 2002 and April 2003, 299 faecal samples were inspected (dry season: November $n=5$, December $n=16$, January $n=27$, February $n=3$, March $n=44$ and April $n=84$; wet season: May $n=45$, June $n=12$, July $n=29$, August $n=20$, September $n=12$ and October $n=2$). Unchewed herbaceous leaves were present in 3.7% of the samples (11/299) and grass in 2.3% (7/299). All leaf-swallowing was recorded during the rainy season from about 1 1/2 months after the onset of the rains onwards (Fig. 2).

Two small worms of ca. 0.5 mm diameter and 1–1.5 cm length found on the outer surface of the herbaceous leaves (cf. Fig. 2) were identified as *Oesophagostomum stephanostomum*. The same worms were present in at least one other sample.

The herbaceous leaves had a hairy surface. The plant was identified as *Desmodium gangeticum* var. *maculatum* (Leguminosae–Papilionoideae). It is known as “takamahi” (“the one that sticks on you”) in Hausa and Fulfulde because its leaves and seeds attach to people’s clothes. Three sets of leaves were measured (set A = 25 and set B = 17 leaves recovered from a faecal sample; set C = 11 leaves from an undisturbed bush of *Desmodium*), indicating little variation in dimension [average length \times width (cm) and ratio average length/average width: A = 8.6 \times 4.3, ratio 2.0; B = 8.8 \times 5.1, ratio 1.7; C = 8.8 \times 5.1, ratio 1.7]. Tissue had disintegrated from most leaves of set A, but was intact in half of those from set B.

Grass recovered from faecal samples was not identified. There were very few grass stems, and many sharp-edged grassy leaves.

Obvious signs of chewing could not be detected in either the herbaceous or grassy leaves.

Table 1 Incidences of leaf-swallowing recorded in Gashaka chimpanzees

Samples containing leaves						
Date	Samples with leaves/ total samples from nest site (<i>n</i>)	Collection time	Fresh weight (g) of faeces	Herbaceous leaves	Grass leaves	Remark
2 July 2001	1/ND	ND	105	x (<i>n</i> =25)	x	
13 May 2002	1/10	9:40	193	x		
29 May 2002	1/4	ND	ND	x (<i>n</i> =18)	x	Sample contained two worms
5 July 2002	2/5	6:30	127	x		Diarrhetic sample
23 July 2002	2/7	8:30	55	x	x	One faecal sample contained two worms but not unchewed leaves
		7:40	121	x	x	
		8:00	47	x		
25 July 2002	1/9	ND	49	x		
10 August 2002	4/5	8:00	93	x	x	
		8:30	158	x	x	
		8:45	129	x	x	
		9:10	29	x	x	

ND No data; x Present in faecal sample

Discussion

Our field study adds *P. t. vellerosus* to the list of leaf-swallowing apes, which includes the three other chimpanzee subspecies, as well as bonobos and eastern

low-land gorillas (Huffman 1997, 2001). So far, leaves from the family Leguminosae-Papilionoideae have not been reported to be swallowed by apes. We have no indication that chimpanzees select leaves of a particular size, as swallowed leaves and those from an intact bush of *Desmodium* had similar dimensions. The grass could not be identified, but it possesses sharp-edged leaves similar to sedge grass (Cyperaceae), which is swallowed in at least two other populations of wild chimpanzees (Huffman 1997).

Various patterns—even in the absence of direct behavioural observations—suggest that chimpanzees

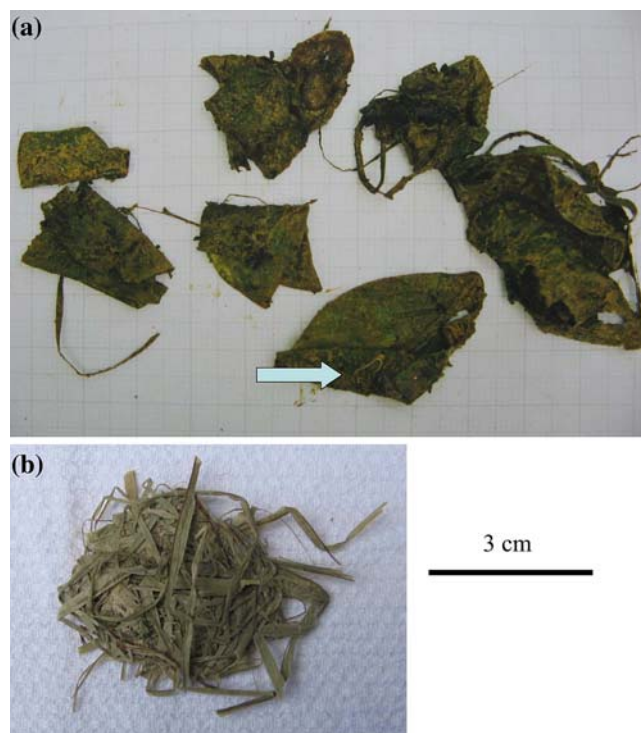


Fig. 1 Leaves, swallowed undigested and recovered from chimpanzee faeces. **a** Folded leaves of *Desmodium* plus several unfolded unchewed grassy leaves (arrow represents *Oesophagostomum* worm on surface of lower leaf). **b** Bundle of grassy leaves

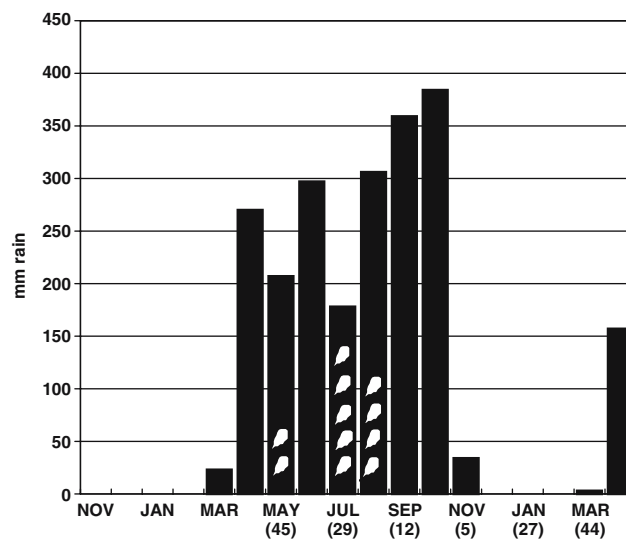


Fig. 2 Rainfall at the study site (November 2001–April 2003) and total number of recovered faecal samples for each month. Symbols on monthly bars indicate number of samples with unchewed leaves

at Gashaka do ingest the leaves for medicinal purposes (cf. Huffman 1997; Huffman and Caton 2001; Dupain et al. 2002): (1) the leaves are either sharp-edged (grass) or have a coarse surface (herb), indicating that they would be suitable for dislodging intestinal parasites and/or triggering a purging response by the gastro-intestinal tract to expel rapidly material that does not digest well; (2) the leaves are not chewed, and excreted whole, indicating that they are not ingested for nutritional purposes; (3) nematode worms (*O. stephanostomum*) were found together with excreted leaves; (4) leaf-swallowing was restricted to the rainy season, during which parasite re-infections are more common.

We will likely learn more about potential medicinal plant use of Nigerian chimpanzees with more direct observations. “Candidate plants” can be derived from local ethno-medical and ethno-veterinarian practices involving at least 99 species (Koutsioni 2003). “Takamahi” leaves are pounded for use as an enema and juice from squeezed leaves is drunk to remove threadworm. These procedures seem to rely on pharmacological properties of *Desmodium* (Latha et al. 1997; N’gouemo et al. 1996). However, other plants swallowed by apes elsewhere (Huffman 1997) expose local humans, cattle and baboons to the scabrid surface of leaves. For example, *Aspilia africana* (Compositae) is fed to cattle while olive baboons consume young leaves of the “sandpaper tree” *Ficus exasperata* (Moraceae) (Warren 2004). We do not know if Gashaka chimpanzees eat these plants. The same holds true for *Vernonia amygdalina*, another Compositae eaten by locals (“bitter leaf”), of which apes elsewhere consume the bitter pith for assumed pharmacological purposes related to parasite control (Huffman and Seifu 1989; Huffman et al. 1997).

The study of animal self-medication attempts to unravel complex animal-plant-parasite interactions and ultimately aims to understand the evolution of self-medication in early hominids (Huffman 2001). Comparative evidence from ape populations across their range of distribution is indispensable for such a research agenda.

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