Acknowledgements
Filming was part of a new three-part series called PRIMATES (working title) for BBC One (a BBC, BBC Studios, PBS and France Télévisions coproduction) to be broadcast worldwide in 2020. The BBC wishes to thank Guy Randriatahina, the whole team at Ankarafa forest, and Christoph Schwitzer for all their help in making the filming possible. We also wish to thank Flávia Esteves, Brendon Boudinot, Chris Birkinshaw and Louise Peckre for their knowledge and guidance.

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Adaptability of *Hapalemur griseus griseus* to a diet containing cyanogenic heteroside

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Introduction
The feeding ecology of primates depends on the morphological adaptations of the dentition and digestive tract and on physiological adaptations (Hladik, 2006). The eastern lesser bamboo lemur (*Hapalemur griseus griseus*) is a folivorous bamboo lemur (Wright, 1986; Tan, 1999; Grassi, 2002; Mittermeier *et al.*, 2014), classified as Vulnerable (Andriaholinirina, 2014). The aim of this work was to enhance our understanding of feeding preferences of eastern lesser bamboo lemurs; specifically, foods consumed per season, habitat types and diets of the species.

Methods
Data collection
An ecological survey of foods consumed by two groups of eastern lesser bamboo lemurs was undertaken in the Maromizaha rainforest during 2016. The study spanned two

seasons: one wet and hot season (November to April) and one dry and cool season (May to October). Data was gathered over 12 days per month; observations were equally split between study groups (6 days per month ~ 1346.25hrs per group total).

Analysis of foodstuffs

In order to understand more about the cyanogenic properties of plant species consumed by eastern bamboo lemurs, phytochemical screening was undertaken to determine the presence or absence of cyanogenic glycosides. This analysis was undertaken using a Grignard test. Cyanogenic glycosides release toxic hydrocyanic acid (HCN) after hydrolysis. The Grignard test involves the use of an indicator paper (Whatman filter paper). Samples were impregnated with an aqueous solution of sodium picrate. The filter paper taking on a red hue is indicative of the presence of cyanogenic glycosides. Although this method is qualitative, it served to provide more information about the presence (or absence) of cyanogenic glycosides in the eastern bamboo lemur diet.

Results and Discussion

The eastern lesser bamboo lemurs in this study predominantly consumed plants belonging to the Poaceae family (Fig. 1), a type of bamboo including *Cephalostachyum* sp., *Panicum* sp1, and *Panicum* sp2 (64.52%). Preference was shown for young shoots and leaves of these plants. However, they also exploited other plants such as *Hypoestes* sp. (Acanthaceae).

Tab. 1: Food sources of eastern lesser bamboo lemur (*H. g. griseus*) containing cyanogenic glycosides

Samples	% of consumption	Observation during tests	Results
Cephalostachyum sp (POACEAE)	24,05 %	No reaction	(-): Absence of cyanogenic glycosides
Panicum sp1 (POACEAE)	38,10 %	Orange red colouring	(+): Presence of cyanogenic glycosides in small quantities
Hypoestes sp (ACANTHACEAE)	1.19 %	No reaction	(-): Absence of cyanogenic glycosides

Cyanogenic glycosides release toxins when hydrolysed. The catabolism of cyanogenic glycosides is therefore initiated upon tissue disruption, due to mechanical damage or ingestion by herbivores (Wajant *et al.,* 1994; Jarrige *et al.,* 1995; Patton *et al.,* 1997). Results of the phytochemical screening of cyanogenic glycosides in the three plant samples found in the eastern bamboo lemur diet demonstrate a small quantity of these chemicals, in particular within the *Panicum* sp1 (Poaceae) (Tab. 1). This species is a widespread plant found in the valleys of the Maromizaha rainforest. It is consumed to an even greater extent by eastern bamboo lemurs during the dry season (52.63%). The excessive consumption of this plant thus has the potential to poison the lemurs. Throughout the study period, irrespective of season, animals descended near to the ground to eat a small amount (1.19%) of soil a few hours post feeding or resting (Fig. 2). In all instances the consumption of soil only occurred after ingestion of cyanide-containing plants. This geophageous behavior may be attributed to the soil helping to neutralize the effects of ingested hydrocyanic acid, a theory which remains a hypothesis (Hladik, 2002; Hladik *et al.,* 2011). This suggests that soil consumption in these eastern bamboo lemurs is helping to offset any harmful effects from the vegetation.

Fig. 1: Male eastern lesser bamboo lemur (*H. g. griseus*) feeding on *Panicum* sp1 (Poaceae). (Photo: Andrianandrasana, Z.A.)

Feeding on soil is commonly observed in primates and is thought to resolve nutritional requirements (Izawa, 1993; Mahaney *et al.,* 1999; Krishnamani and Mahaney, 2000; Blake *et al.,* 2010; Hladik and Gueguen, 2011). Studies by Glander *et al.* (1989), Tan (1999) and Jeannoda *et al.* (2003) on foods eaten by golden bamboo lemurs (*Hapalemur aureus*) indicate that bamboos have toxic substances: tannins or glycoalkaloids, with varying toxicities. Tannins (as polyphenols) are abundant yet not very toxic, even at high doses (Hladik *et al.*, 2000). Research indicates there is no means of animals removing these toxic substances from the plant itself; rather, consumers must process them internally (Hladik *et al.*, 2000). Jeannoda *et al.* (2003) recommends consideration of physiological adaptations of lemurs when trying to understand how they process particularly toxic bamboo species. In eastern bamboo lemurs we hypothesise that individuals may have physiological adaptations to the cyanide contain-

Fig. 2: *Hapalemur g. griseus* feeding on soil. (Photo: Andrianandrasana, Z.A.)

ing diet. Tan (2006) suggested that processing cyanogens to avoid the toxic effects may involve a specific enzymatic pathway that is unique to the lemur and may yield insights into *Hapalemur*-bamboo coevolution.

The phytoanalysis undertaken in this study indicated that the level of toxic substances in the diet of the eastern bamboo lemurs studied may not be particularly high. However, after excessive consumption of bamboo, especially the young bamboo leaves, the eastern bamboo lemurs were observed to either consume a small quantity of soil or to drink water. Lemurs were even observed descending to the valley level in Maromizaha rainforest to drink at streams in high temperatures. Taken together these findings suggest that eastern bamboo lemurs are showing behavioural adaptations to their potentially toxic diet, but physiological adaptations must not be ruled out. This research contributes to our understanding of how eastern bamboo lemurs are adapted to their specialised diet.

Acknowledgments

Our sincere thanks are addressed to the Ministry of the Environment, Ecology and Forest of Madagascar for giving permission to conduct research, le Groupe d'Etude et de Recherche sur les Primates (GERP) which gave a favourable opinion to the realization of this study in the Maromizaha New Protected Area. We also thank the Centre National d'Application des Recherches Pharmaceutiques (CNARP) for the photochemical analysis in this study.

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The elusive *Allocebus trichotis:* new records of hairy-eared dwarf lemurs in the northwest of Marojejy National Park

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A short paper published in *Lemur News* more than two decades ago by Anne Yoder (1996) started by saying "… The Malagasy primate *Allocebus trichotis*, the hairy-eared dwarf lemur, is undoubtedly the least studied and possibly the rar-