HOW ORANGUTANS CHOOSE WHERE TO SLEEP: COMPARISON OF NEST-SITE VARIABLES

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ABSTRACT

Primates spend a significant proportion of their lives at sleeping sites, and the selection of a secure and stable nest tree can be crucial for the individual's survival and fitness. This study examined nesting site preferences of Southern Bornean Orangutans *Pongo pygmaeus wurmbii* (Tiedemann) in a degraded peat-swamp forest in the Sabangau catchment, Central Kalimantan, Indonesia. Orangutan nests were identified during transect walks. Orangutans most frequently nested in trees in the families Anacardiaceae and Elaeocarpaceae. Orangutans preferentially chose trees with stilt roots or buttresses. We suggest that orangutan nest site selection is driven by comfort and stability rather than predator avoidance. The findings underline the importance of conserving habitat not only for food species, but also for nest-site species.

Keywords: location choice, nest tree, *Pongo*, security, sleeping-site

INTRODUCTION

Orangutans are arboreal apes with a geographic distribution limited to Borneo and Sumatra. Like other large-bodied apes, orangutans build night nests (MacKinnon, 1974; Morrogh-Bernard *et al.*, 2003; Ancrenaz *et al.*, 2004; Russon *et al.*, 2007; Morrogh-Bernard, 2009) which they rarely re-use. Day nests are constructed less frequently than night nests (van Schaik *et al.*, 1995; Ancrenaz *et al.*, 2004; Mathewson *et al.*, 2008): on average once every eight days in Borneo (Husson *et al.*, 2009). They are generally looser and have lower structural complexity than night nests; no differences have been noted in tree species used for day versus night nests.

Perhaps because of their large size, Bornean Orangutans *Pongo pygmaeus* (Linneaus) are thought to have few natural predators, and only records for predation by Sunda Clouded Leopards *Neofelis diardi* (G. Cuvier) have been reported (MacKinnon, 1974; van Schaik, 1983; van Schaik & van Hooff, 1996). Anderson (1998) posited that large apes are perhaps less concerned with predation avoidance than might be true of smaller primates, and instead favour nest trees that offer a comfortable place for the night (e.g. sites protected from wind and rain). Orangutans may sleep low in the forest canopy so that they are protected from wind and rain as well as evening and morning sun, but their relatively high body mass could also reduce the suitability of higher branches (Anderson, 1998).

Here we investigate characteristics of nest sites selected by the Southern Bornean Orangutan *Pongo pygmaeus wurmbii* (Tiedemann) in the Sabangau catchment, Central Kalimantan, Indonesia. The Bornean Orangutan is listed by the IUCN Red List as Endangered (Ancrenaz *et al.*, 2008) due to habitat loss and fragmentation, forest fires, hunting and the pet trade. Sabangau catchment is home to what may be one of the world's largest populations, with 6,000 orangutans (Morrogh-Bernard *et al.*, 2003) at a density of 2.28 individuals/km^2 - thus Sabangau supports a moderate density of orangutans compared with other sites (range 0.06 to 7.04, mean 1.98: Husson *et al.*, 2009). The area has been selectively logged (Page *et al.*, 1999) and thus availability of suitable nest sites may have been reduced. Various external loads and internal stresses act on trees and may affect their stability (Mattheck, 1994), i.e. their susceptibility to swaying in the wind. Orangutans might thus be expected to prefer trees with larger diameters and other features that increase stability (e.g. buttressed or stilted rooting systems).

METHODS

Study area

This work was carried out in the northern Sabangau forest, Central Kalimantan, Indonesia (Fig. 1), one of the largest peat-swamp forests in the world (Page *et al.*, 1999; Harrison *et al.*, 2010) and specifically in the Natural Laboratory of Peat-swamp Forest (S2.31° and E113.90°), operated by the Center for International Cooperation in Management of Tropical Peatland (CIMTROP). Data were collected throughout the year and all age-classes of orangutan nests were included. Behavioural and ecological studies at the site date from 2003 for orangutans (Morrogh-Bernard *et al.*, 2003).

Data collection

Data used in the present study were collected between July and September 2008. DR collected data on 180 orangutan nest trees which were located by transect walks (three transects of 2 km were walked twice each [separated by 30 days] for a total extent of 12 km). For this study nest trees were considered only where the orangutans exclusively used branches from a single tree to build the nest (120 of 180). Cases where more than one tree was used to make a nest were removed from the dataset, as it was not always clear which of these trees was the main support tree from which to measure tree characteristics. Data were not available on which age/sex class made the nest nor whether it was a day or night nest.

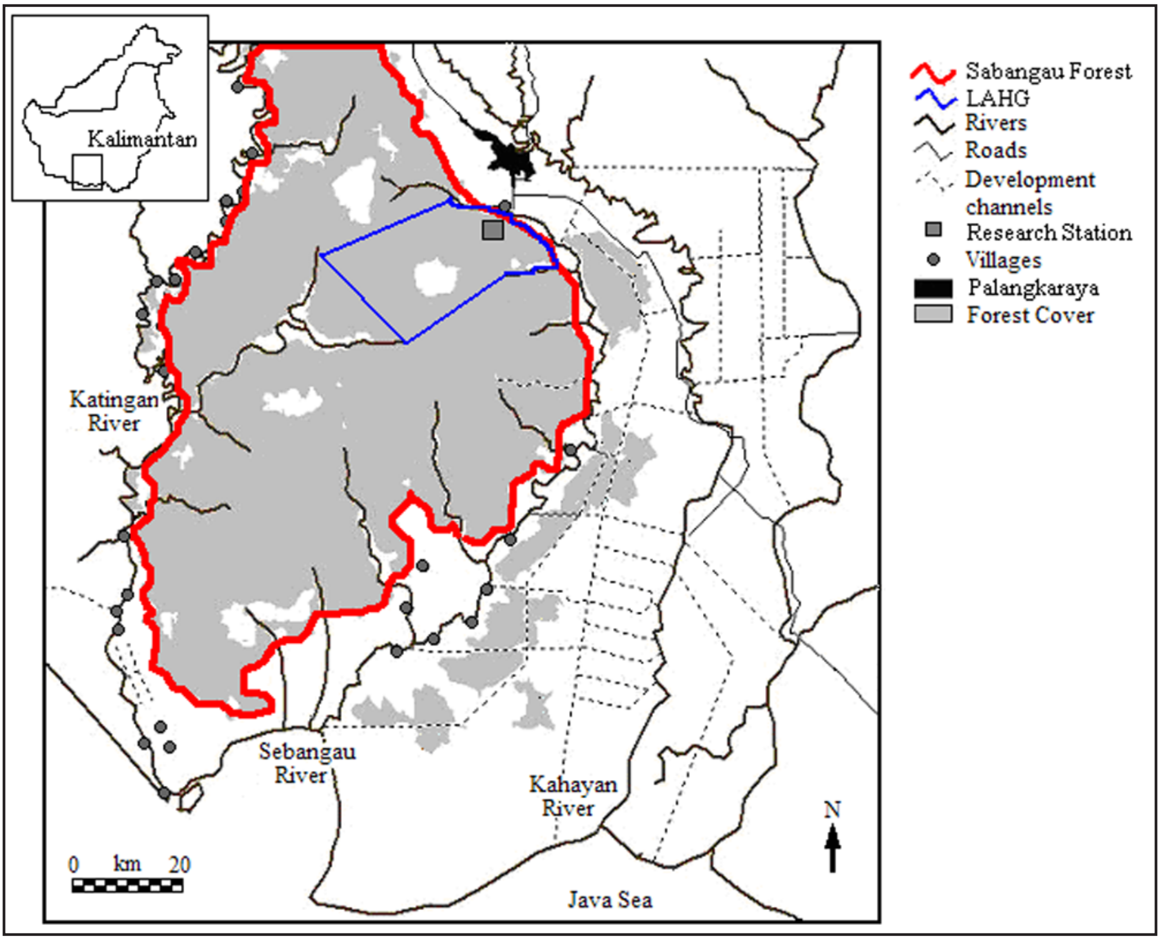

Fig. 1. Location of the Natural Laboratory for Peat-swamp Forest in the northeast of Sabangau catchment (in blue box)

All nest trees were identified to species level by knowledgeable local assistants, as well as using detailed species lists and descriptions for the study area (Harrison *et al.*, 2010). Data from six long-term phenology plots were used to determine whether the nest tree species are consumed by orangutans, and these plots were used to obtain the general abundance of tree species throughout the study site. Tree height class was visually estimated (1-5 m, 6-10 m, 11-15 m, 16-20 m, 21-25 m, 26-30 m, 31-35 m, 36-40 m or >40 m: Cheyne, 2010) following extensive training, and results averaged for analysis. Each tree's diameter at breast height (DBH) and basal circumference was measured. Basal circumference (Law *et al.*, 2008) was used as an indicator of the total area on the ground covered by the tree and an indicator of the spread of the weight of the tree and the accompanying supporting roots.

The trunks were qualitatively categorized as "buttress", "stilt" or "straight". The subjective categorization of canopy cover, root system, and exposure (the estimated percentage of the tree exposed to the wind) was made by DR for all orangutan nest trees. "Control" trees surrounding each nest tree were measured for all the above variables to provide data on general features of trees that were available but not selected, compared with those chosen by the apes (150 control trees >13 m).

Data analysis

Data was analysed in relation to tree family, tree height (in 5 m categories), canopy cover above the nest, root system, DBH, basal circumference (a proxy for stability), exposure (the inverse of the percentage of the tree canopy surrounded on a horizontal plane by canopy from other trees), and angle of the tree to the ground.

For individual predictor variables we used MANOVA to determine whether nest trees differed significantly from non-nest trees. Which variables were responsible for the preference given to a species was then tested by means of a multivariate analysis in the form of a Discriminant Function Analysis to identify any relationships between the significant variables and the degree of selection. Due to small sample sizes in some tree height classes, tree height data were analysed only descriptively. Statistical tests were carried out using SPSS 17.0, R 2.10.1 and OpenOfficeCalc, and MANOVA were two-tailed with α set at 0.05. Sample sizes for orangutan nest trees were always the same (N=120 nest trees and N=150 control trees).

RESULTS

Tree families

The 120 nest trees belonged to 52 species, in 14 or more families (three trees could not be identified). The largest proportion of orangutan nest trees belonged to the family Anacardiaceae (N=27 of 120; 22.5%). Orangutans slept in food-species trees on 75% of occasions (90 of 120 trees) and these trees contained edible parts on 40% of occasions (36 of 90 trees). Of the principal available canopy trees defined by Page *et al.* (1999), only four (22%) were used as nest trees and these belonged to the families Clusiaceae and Annonaceae. Of these four species, three (*Xylopia fusca* Maingay ex Hook.f. & Thomson, *Calophyllum hosei* Ridl. and *C. sclerophyllum* Vesque) are food species, but did not contain edible food parts at the time they were used as nest trees. Of the 52 species, eight species were found to be nested-in at proportions significantly different to those at which they are found in the forest as a whole. Of these, six (Table 1) showed a positive association (i.e. had a positive Jacob's D coefficient), but together these accounted for 52% of nest site selections. Only two species (*C. hosei* and *Palaquium leiocarpum* Boerl.) showed a significant negative association (Table 1).

Table 1. Tree species with significant positive or negative Jacob's D associations by nesting orangutans.

Species	Local name	Jacob's D
Diospyros areolata King & Gamble	Malam Malam	1.00
Elaeocarpus mastersii King	Mangkinang	0.92
Litsea grandis var. rufofusca (Kosterm.) Ng	Tampang	0.79
Campnosperma coriaceum (Jack) Hallier f.	Terontang	0.71
Tetranthera elliptica (Blume) Nees	Medang	0.65
Lithocarpus sp. 3	Pampaning Bayang 1	0.48
Calophyllum hosei Ridl.	Jinjit	-0.67
Palaquium leiocarpum Boerl.	Hangkang	-0.77

Individual predictor variables

Orangutan nest trees were lower than the surrounding canopy (mean nest tree height=15.1±SE0.43 m; range 1-5 to 31-35 m, N=120; mean control tree height=20.1±SE0.43 m; range 1-5 to 31-35 m, N=150). Exposure did not significantly predict presence of nests (Wilks' λ=0.997, F [0.328], p>0.05) but a closed canopy did (Wilks' λ=0.836, F [5.546], p<0.001). Trees with buttress or stilt roots (thus by association a large basal area) contained nests significantly more often than trees with no above-ground roots (Wilks' λ=0.973, F [8.610], p<0.005). Vertical trunks with respect to the ground were significantly more likely to contain nests than angled trunks (Wilks' λ=0.982, F [5.517], p<0.05). Orangutans made a nest in trees with large DBH significantly more often than in small DBH trees (Wilks' λ=0.845, F [5.419], p<0.05).

Discriminant Function Analysis

The DA method indicated that nest tree choice was most strongly related to the percentage canopy cover, the angle of the trunk, the root system of the tree and tree DBH (Table 2).

DISCUSSION

There was no evidence that orangutans were selecting trees to avoid predation, but indirect evidence showed that they were selecting sites based on comfort, specifically protection from wind and rain. Orangutans did show a clear preference for trees with larger diameter and features (e.g. buttressed or stilted rooting systems, and larger basal area) which reduce swaying in the wind (Nicoll & Ray, 1996; Soethe *et al.*, 2006).

Orangutans may choose comparatively low nest locations within the tree so that they are protected from strong wind, rain and sun (Anderson, 1984). Tree height tends to be proportional to DBH (Law *et al.*, 2008). Our results indicate that there is a positive relationship with DBH, i.e. orangutans select trees with a large DBH, despite the preference for lower tree height. Ancrenaz *et al.* (2004) found that in logged forest, tall trees were preferred for nesting sites, and most nests were in the upper part of the tree crown, where more leaves were available, and where the apes were not directly exposed to sunlight or rain. While the trees selected by Sabangau orangutans were not very high, they represented the upper crown and to this extent our findings support the results of Ancrenaz *et al.* (2004).

Six species made up 52% of nest tree selections, suggesting they may be especially attractive to nesting orangutans. Conversely two relatively abundant species, *C. hosei* and *P. leiocarpum*, were used less than expected by chance.

The importance of nest trees as a key component in orangutan habitats needs to be highlighted and prioritised for any habitat conservation initiative. Further investigation would be justified for this reason, including behavioural data and data on the individual orangutans which made the nest, to tease out differences in sex, or whether females with infants select nest sites for safety over stability.

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Table 2. DA analysis (Wilk's Lambda) of four tree characteristics.

Step	Variable entered	Wilk's Lambda Statistic	Exact F Statistic	df1	df2	Sig.
1	Canopy cover	0.813	64.821	1	165	0.000
2	Angle of basal trunk	0.795	38.070	2	163	0.000
3	Root system	0.755	31.621	3	161	0.000
4	DBH	0.632	16.802	4	157	0.000

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