Nest characteristics of Yellow-billed Kites *Milvus aegyptius* in the Manambolomaty Lakes Complex, western Madagascar

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We studied the nesting biology of Yellow-billed Kites *Milvus aegyptius* in the Manambolomaty Lakes Complex of western Madagascar during 2002 and 2003. We recorded 64 nesting attempts. In 2003, 33% (n = 39 nests) of the occupied nests were from the previous breeding season. The average time for building new nests was 57 d (SD = 30.6; range 18–83 d; n = 5 nests). Males contributed 75% of the nesting material. All nests were built of dry sticks and other unique nest materials. During the nest building period, 83% (n = 241) of the dry sticks were collected less than 50 m from the nest tree. The unique nest material was collected from the ground and delivered to the nest 10 d prior to egg-laying. The average distance between neighbouring nests was 264 m (SD = 270.8, range = 26–1 081, n = 33 nests). Yellow-billed Kite nests averaged 9.6 m (SD = 2.4; range 4–14.8 m; n = 64 nests) above ground level and 64% (41 of 64 nests) were in tamarind trees (*Tamarindus indica*). Nest trees mean DBH was 63.9 cm (SD = 28.1, range 25–200 cm; n = 64 nests).

Keywords: Manambolomaty Lakes Complex, *Milvus aegyptius*, nest characteristics, western Madagascar, Yellow-billed Kite

Introduction

Milon et al. (1973), Brown and Amadon (1989) and Langrand (1995) considered only one species of kite to occur in Madagascar, the Black Kite *Milvus migrans*, represented by the subspecies *M. m. parasitus* (Ferguson-Lees and Christie 2001). The subspecies most similar to *M. m. parasitus* is *M. m. aegyptius*, which occurs in northern and north-eastern Africa. However, Morris and Hawkins (1998) classified the kite in Madagascar as a separate species, *M. aegyptius*. The same year, Sinclair and Langrand (1998) published the existence of two species of *Milvus* kites in Madagascar: the Yellow-billed Kite *M. aegyptius* and the Black Kite *M. migrans* following Ferguson-Lee and Christie (2001). These two species are distinguished by the colour of their beaks: yellow in *M. aegyptius* and black in *M. migrans*. Ferguson-Lee and Christie (2001) state that *M. aegyptius* is found in Africa and the Indian Ocean region, whereas *M. migrans* is common in Africa, Asia and Australia. Ferguson-Lee and Christie (2005) presented *M. aegyptius* as a separate species from *M. migrans*. Thus, in Madagascar and Sub-Saharan Africa, the species is represented by *M. aegyptius parasitus*.

The Yellow-billed Kite is a common gregarious raptor and distributed throughout Madagascar, whereas the Black Kite *M. migrans* is found only in the dry southern region of the country (Langrand 1995, Sinclair and Langrand 1998). In Madagascar, both species are poorly known and little information exists even on nesting and breeding ecology (Langrand 1990, 1995). For instance, the nesting period for both species has been reported to begin in September (Langrand 1995). The Yellow-billed Kite in Madagascar is known to nest in loose colonies in trees (Langrand 1995, Morris and Hawkins 1998). However, movements of Yellow-billed Kite are not yet well defined in Madagascar (Sinclair and Langrand 1998).

This paper summarises information collected during 2002 and 2003 on the nesting biology of the Yellow-billed Kite in western Madagascar and describes the nest characteristics.

Study area and methods

This study was conducted in the Manambolomaty Lakes Complex (MLC) (19°01′ S, 44°26′ E), in the Antsalova region of western Madagascar from June to December 2002 and May to December 2003. MLC is a complex of three lakes – Befotaka (3.86 km^2), Soamalipo (4.86 km^2) and Ankerika (3.09 km^2) – and is surrounded by the tropical dry deciduous Tsimembo Forest (Bousquet and Rabetaliana 1992, Rahantamalala 1993). The forest is characterised by a canopy height of 12–15 m with a few distinct trees emergent up to 25 m (Bousquet and Rabetaliana 1992, Programme Bemaraha 2002). However, we extended our surveyed area up to 500 m from the edge of the lakes. There are two distinct climatic seasons: a dry season from April to November and a rainy season from December to March (Oberlé 1981). During the two-year study period, we recorded 827 mm of average annual rainfall with a mean of 51 rainy days and the average annual temperature was 26 °C.

Surveys of individual and nesting Yellow-billed Kites were conducted by locating vocalising birds and searching for stick nests in trees surrounding the lakes, especially during the morning between 06:00 to 09:00 when the birds were active in their nesting territories, by foot or dugout canoes. The individual census was made during two days of July when most of the Yellow-billed Kite pairs can be identified along with their territories.

Information about existing nests was also collected from locals and fishermen. In order to determine the reuse of existing nests during the 2003 season, each nest was classified as newly built or had been used during the previous year. The nesting cycle for each nest was recorded when possible. A nest with eggs was noted as an active nest.

Nest observations were conducted from the nest building to the fledgling periods. We carried out observations from 05:30 to 18:30 at a distance of 25–50 m from the nest tree. For nest construction, we recorded the duration each individual of a pair spent building the nest. Re-nesting occurred when the pair built another nest in the same territory during the same breeding season. Yellow-billed Kites are not sexually dimorphic, so each individual of a pair was identified by plumage characteristics. We assumed that the male also provided food to its mate prior to copulation or during nest construction (Newton 1990); this behaviour, in combination with plumage characteristics, therefore helped to identify the sex of the pair.

Statistical analysis was conducted using SPSS 17 (SPSS, Chicago, USA, 2010). The Mann-Whitney test was used to compare nest-building activities between males and females.

The shortest distance of nest trees from the lakeshore and human habitation (Watson et al. 2000) was measured to determine nesting habitat characteristics. Nearest distance of neighbouring nests was measured to calculate nest dispersion. The relationship between parameters of nest dispersion was analysed with Spearman's correlation. The density of Yellow-billed Kites was estimated by the number of individuals per area unit within the surveyed area.

To avoid disturbance during the nesting period, nest measurements and characteristics were recorded after young had fledged. Measurements included nest tree diameter at breast height (DBH), nest width, nest depth, and nest height from ground (Koga et al. 1989, Watson et al. 2000). In addition, nests were randomly chosen to determine the length and diameter of nest sticks, distance from nest of nesting material and nest placement in the tree canopy for estimating exposure to the sun.

Location and geographical data were collected using a hand-held global positioning system (GPS) and a 100 m measuring tape. ArcView GIS 3.3 (ESRI, Redlands, USA, 2002) was used for spatial analysis and mapping, and the surveyed area was calculated by using the Arcview Geoprocessing extension. The area shape was created with the buffer analysis from lakeshore, and then the area value (in km^2) was calculated by executing the Get-Area command in the shape attribute table.

Results

Nest census

In 2002, we located nine nests with one nest observed as newly constructed and eight nests as occupied by pairs at the beginning of the study in June 2002. Eight nests were reported from information provided by locals and fishermen, of which six were used for continuous observation. During May 2003, 12 nesting attempts were used for continuous observation. In October 2003, we located 64 nests around the three lakes (Figure 1), of which one nesting pair was still observed delivering nesting material to a nest that did not contain eggs, 15 nests were found during incubation, 20 with nestlings and 28 nests at unknown stages. During 2003, 66.7% (26 of 39 nests) of active nests were newly constructed and 33.3% (n = 13 nests) were nests reused from the 2002 breeding season.

Nest building period

During the two-year study, we totalled 1 370 h of nest observations during the nest building period. Yellow-billed Kites began nesting in June and both sexes participated in nest-building activities. Of 427 nest material deliveries, males contributed 75% (n = 320 items) and females delivered 25% (n = 107 items). The peak time for nest material deliveries by females occurred between 07:00 to 08:00 with 30.8% (n = 33) of total deliveries and males was between 07:00 to 09:00 with a 46.5% (n = 149) of male's materials delivered (Figure 2).

However, females spent a significantly longer time (Mann-Whitney U = 13 985.5; $p < 0.01$) arranging nesting material with an average bout of 15.2 min (range 1–125 min, n = 162 bouts) compared to males at 7.2 min (range 1–60, n = 267 bouts) (Figure 3). Nesting kites collected dry sticks, generally from tamarind trees with their feet and beaks. All unique nesting material consisted of rags, stones, chalky mud, old plastic bags, bryophytes, dog faeces and dung from Zebu cattle were collected from the ground. Of 241 nest material deliveries, 83.4% (n = 201 sticks) were collected less than 50 m from the nest tree, 14.5% (n = 35 sticks) between 50–100 m and 2.1% (n = 5 sticks) greater than 100 m. All dry sticks were delivered before the addition of the unique nesting material was added. Most of the unique nesting material (n = 59.8%) was delivered 10 d before the first egg was laid. During the incubation period, seven pairs delivered additional unique nesting material, especially dog faeces and cattle dung (n = 43 items).

New nests were built on average in 57.2 d (SD = 30.6; range 18-83 d; n = 5 nests). For one nest it took up to 90 d to complete the nest before the first egg was laid. Two pairs spent 70 d repairing a previous year's nest before laying eggs. In total, we recorded four re-nesting attempts of which one pair made a new nest in 20 d, one pair re-nested in its previous' years nest and two pairs stopped nesting activities. In 2003, one pair had two nests: the first was a newly constructed nest and they laid two eggs: one on 30 July and another on 2 August. On 20 August, we observed strange incubating behaviour by the pair and we checked the nest and found no eggs present, but we did find egg shell fragments scattered on the ground 7–10 m from the nest tree. On 22 August, this pair re-nested 61.5 m from the nest that failed and constructed a new nest in 18 d and began incubation of two eggs on 8 September. A previous year's nest within their nesting territory was used as a source for nesting material of both dry sticks and some unique nesting

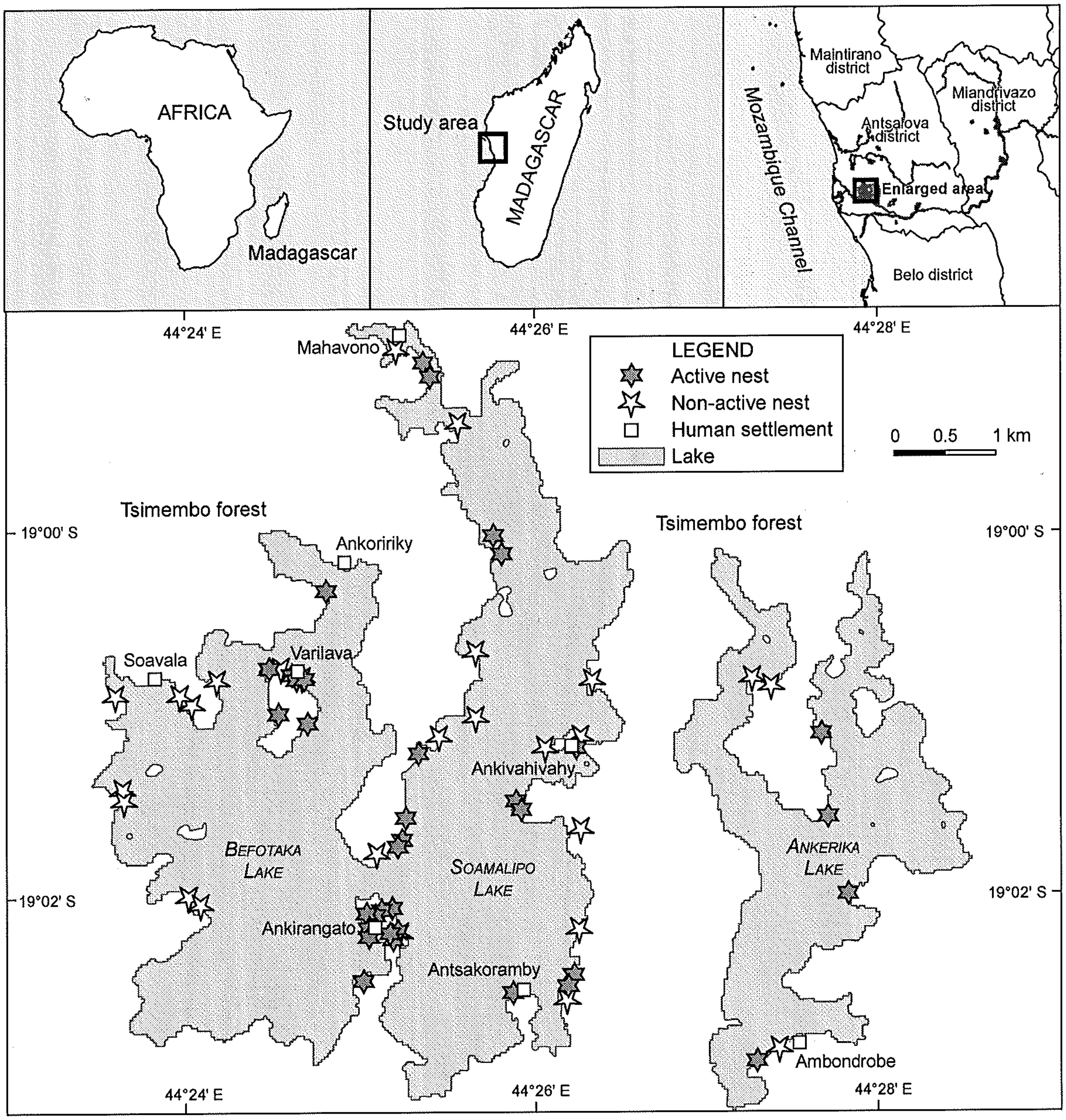

Figure 1: Map showing nest locations of Yellow-billed Kites in 2003.

material, and it was also used as a site for prey exchanges (n = 8 items) during the nesting season.

Nest dispersion

Yellow billed Kite nests averaged 67.1 m (SD = 88.1; range 5–500 m; n = 64 nests) from the lakeshore (Figure 1). Fifty percent of the occupied nests were located within a distance of 450 m from fishing camps (range 29–446 m; see Figure 4). The distance between two neighbouring nests ranged from 26 to 1 081 m (mean 264.6 m, SD = 270.8, n = 33 nests). Neighbouring nest distance decreased as pairs nested closer to the fisherman camps (Figure 5) ($r_{spearman} = 0.63$; $P < 0.001$).

In the 2003 season, of the 39 actives nests found, 14 were at Befotaka, 19 at Soamalipo and six at Ankerika Lakes. The density of Yellow-billed Kite was 2.3 individuals km^{-2} across the whole surveyed area (54.43 km^2).

Nest characteristics

Yellow-billed Kite nests were built in trees averaging 9.6 m (SD = 2.4; range 4–14.8 m; n = 64 nests) above ground level. Nests were supported by two to three branches and 64% (41 of 64) of nests were in trees of tamarind *Tamarindus indica* (Leguminosae; Table 2). Fourteen other nest tree species were identified and two were unidentified. Nest tree mean DBH was 63.9 cm (SD = 28.1, range 25–200 cm; n = 64 nests).

Yellow-billed Kite nests were round with an inner depth varying from 2 to 9.5 cm (n = 18 nests, Table 3). Nests were not fully exposed to the sun, but were shielded by

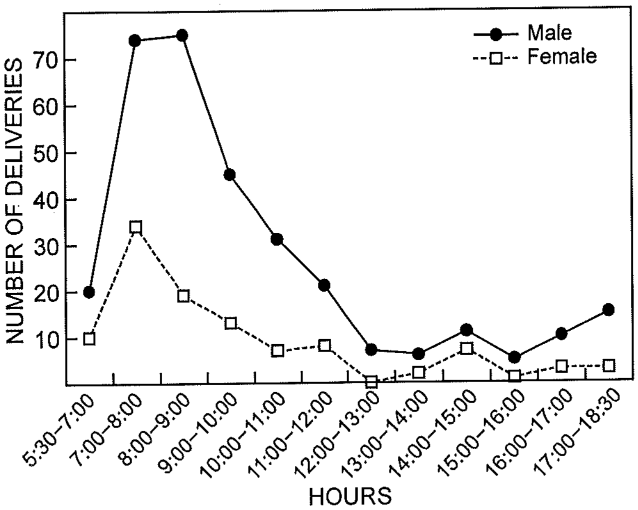

Figure 2: Daily nest material delivery by male and female Yellow-billed Kites (n = 427 total nest material delivered by both sexes)

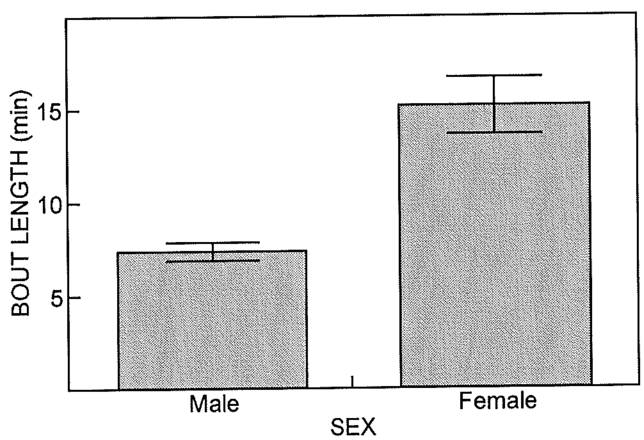

Figure 3: Average (±SE) length of nest-building activity bouts by male and female Yellow-billed Kites at Manambolomaty Lakes Complex in western Madagascar (n = 11 pairs)

foliage with canopy coverage averaging 55% (SD = 18.8, range 20–80%, n = 18 nests). The measurements of sticks from seven random nests averaged 35.5 cm in length (SD = 29.4; range 3–85 cm; n = 14 sticks) and 10.6 mm (SD = 8.6, range 1.5–25 mm, n = 14 sticks) in diameter. The dry sticks formed the nest platform and lower layer, whereas the unique nesting material formed a separate layer on top of the dry sticks.

Discussion

Similar to Black Kites *M. migrans* in India (Brown and Amadon 1989), Yellow-billed Kites at the Manambolomaty Lakes Complex tended to reuse their previous years' nests, but other nesting pairs also construct one or more nests later in the season. New nests were built not far from non-occupied nests and this is why we considered them belonging to the same pair or at least built by one of the same individuals of the pair. Newton (1979) stated that

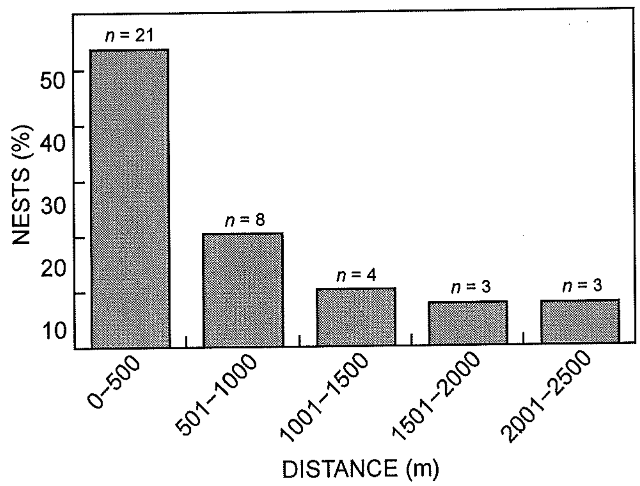

Figure 4: Number of Yellow-billed Kite nests located near fishermen camps (n = 39 nests)

some large raptors do change their nests from year to year, but in such cases usually place them near the previous years' nests. Rene de Roland (2000) recorded the distances between old and new nests of Henst's Goshawk *Accipiter hensti*, a Malagasy-endemic raptor species and one of the larger raptors in Madagascar, between 150–300 m. For another endemic Malagasy raptor, the Madagascar Harrier-hawk *Polyboroides radiatus*, the distance from a previous years' nest to a new nest was 50 m (Thorstrom and La Marca 2000). For Yellow-billed Kite, constructing a new nest not far a previous nest might have a relationship with the size of nesting territory they can defend.

In the Manambolomaty Lakes Complex of the western Madagascar, Yellow-billed Kites began building nests in June, 3 months earlier than reported by Langrand (1995) for Madagascar, and the kites breed during the dry season (April–November), a feature that is shared with other species of Madagascar raptors (Rene de Roland 2000). As nest construction occurs non-continuously until the laying date, some pairs were observed building nests at the end of September, especially pairs making late nesting attempts or because of re-nesting attempts after an earlier nest failure. In addition, fish waste discarded from fishermen processing their catches becomes available for the kites from June to September (the traditional fishing period). From October, the fishermen start to reduce their fishing activity around the Manambolomaty Lakes Complex (Rabearivony et al. 2008) and therefore decrease the amount of fish waste for the kites. Consequently, Yellow-billed Kites may experience difficulty in provisioning their nestlings later in the breeding season.

The average distance between two occupied neighbouring nests in the Manambolomaty Lakes Complex was 265 m and was similar to Black Kites in Doñana National Park, Spain, with an average of 205 m (Sergio et al. 2005). However, in the Manambolomaty Lakes Complex the nearest neighbour nests were much closer than those of Red Kites at 893 m (range 690–2 250 m) (Bustamante and Hiraldo 1990) in Doñana Biological Reserve, south-western Spain and 800 m (Sergio et al. 2005) in Doñana National Park. We believe this shorter distance between

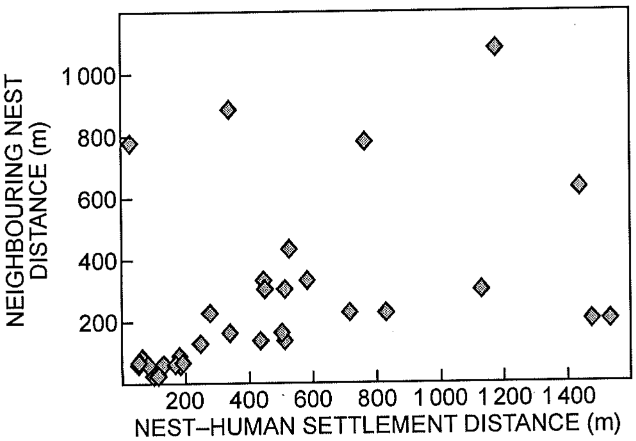

Figure 4: Relation between neighbouring nest distance and nest distance from human settlements (villages and fisherman camps) of Yellow-billed Kites at the Manambolomaty Lakes Complex ($r_{spearman} = 0.63$; $P < 0.001$)

nearest neighbour nests in our study was based on the proximity of available food resources. Yellow-billed Kites at Manambolomaty Lakes placed their nests close to fishing camps where foraging opportunities were associated with opportunistic scavenging of fish waste tossed and left by fishermen during their preparation of fish for drying. It was also easier for the Yellow-billed Kites to collect other unique nesting material found in fishing camps or villages such as rags and animal faeces when nesting closer to humans.

Also, a congregation of nesting pairs provided protection from other predatory birds such as the Madagascar Harrier-hawk and sometimes to other individuals outside of the loose-knit nesting group in protecting their food resources. For the Japanese Black-eared Kite *Milvus migrans lineatus*, an aggregation distance between pairs was 80 m (range 18–168 m) and was related to abundance of resources within the foraging sites and trees suitable for nesting (Koga et al. 1989). We believe this is similar to what we observed for nesting Yellow-billed Kites at the Manambolomaty Lakes Complex.

Langrand (1995) remarked that the Yellow-billed Kite is an undemanding species found in varying habitats, but has a preference for wetlands. In the Manambolomaty Lakes Complex, Yellow-billed Kite nests were placed near the lakeshore allowing them an advantage and easy opportunity to acquire food items such as dead fish floating in the lakes. To ensure this food resource opportunity, Yellow-billed Kites extended their surveillance over open water when their nest was situated close to the lakeshore. Beyond this surveillance area, kites can be found together as their aggression becomes lower. Forero (1998) and Sergio et al. (2003, 2005) found a strong association of Black Kites with freshwater habitats. Also, Dombrovski and Ivanovski (2005) observed that Black Kites were strongly tied to floodplains of large rivers in eastern Belarus.

Yellow-billed Kite nests in our study area were built about 10 m above the ground and were much lower than Madagascar Buzzards *Buteo brachypterus* (Berkelman 1993) and Puerto Rican Broad-Winged Hawks *Buteo platypterus* (Delannoy and Tossas 2002) at 19 m. Thorstrom et al. (2001) mentioned Grenada Hook-billed Kites *Chondrohirax uncinatus mirus* nest height varied depending on the stature of the forest being used for nesting. Razafindramanana (1995) stated that the tree height on the edge of Tsimembo Forest, the same forest in our study area, ranged from 12 to 15 m and the structure of this forest is the reason Yellow-billed Kite nests were lower than other raptors reported above, but similar to 7 m for Black-eared Kites on Nagasaki Peninsula of Japan (Koga et al. 1989).

Nests used in 2002 were structurally strengthened during the following breeding season in 2003 by the addition of more nesting material. The observation of two layers making up the Yellow-billed Kite nests at the Manambolomaty Lakes Complex is interesting, especially the addition of the top unique nesting material layer. Brown and Amadon (1989) noted that green leaves were rarely found in nests of *Milvus* species, but the existence of odd nesting material was fairly common. The use of animal faeces and dung could also be used as nesting materials to help in gas exchange and humidity control for the eggs during incubation, to minimise parasite infestations and possibly as a form of nest advertisement for displaying activity and occupancy (Newton 1979, Palmer 1988). Sergio et al. (2011) reported for *Milvus migrans* in Doñana National Park that nest decoration was used as an extended phenotype signal of threat against conspecific intruders. We did not test this relation but conspecific trespassers were

Table 1: Tree species used by Yellow-billed Kites for nesting during 2002–2003 at the Manambolomaty Lakes Complex in western Madagascar ($n = 64$ nest trees)

Tree species	*n*	%
Tamarindus indicus	41	64.1
Terminalia tricristata	3	4.7
Cleidon capuron	2	3.1
Neobeguea mahafaliensis	2	3.1
Stereospermum euphorioides	1	1.6
Foetidia retusa	3	4.7
Adansonia sp.	1	1.6
Gyrocarpus americanus	1	1.6
Cynnometra comersoni	1	1.6
Perriera madagascarensis	1	1.6
Diospyros sp.	1	1.6
Kigelia madagascarensis	1	1.6
Rhopalocarpus lucidus	1	1.6
Cedrolopsis grevei	1	1.6
Albizia lebbeck	2	3.1
Unidentified species	2	3.1
Total	64	100

Table 2: Yellow-billed Kite nest characteristics at the Manambolomaty Lakes Complex in western Madagascar during 2002 and 2003 ($n = 18$ nests)

Nest characteristic	Mean ± SD	Range
Diameter (cm)	51.4 ± 15.1	24–81.2
Depth inner (cm)	5.1 ± 1.8	2–9.5
Depth outer (cm)	35 ± 3.7	20–66
Nest cover (%)	55 ± 18.8	20–80

not tolerated by Yellow-billed Kites, and intrusions into the breeding territory were followed by violent attacks.

Sinclair and Langrand (1998) reported Yellow-billed Kites are similar in behaviour to Black Kites, which colonise all type of biotopes except densely wooded regions. The choice of using tamarind as the nest tree is related to the ecological function of this tree species. Tamarind trees prefer semi-arid areas and wooded grasslands and can be found along streams and riverbanks (Orwa et al. 2009). Using a tamarind tree for nesting, Yellow-billed Kites facilitated their ability to collect nesting materials as most nests were constructed of dry tamarind sticks. After the deciduous period, the leaves of tamarind regenerate earlier than other trees in the Manambolomaty Lakes Complex and provided canopy coverage from the direct sun for the kites during the nesting season (TA pers. obs.).

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