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REPORT 25

The Effect of Forest Species Degradation on Avifaunal Diversity and Community Composition in Dry-Deciduous Forests, Northern Madagascar

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The Effect of Forest Species Degradation on Avifaunal Diversity and Community Composition in Dry-Deciduous Forests, Northern Madagascar

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Frontier-Madagascar

Madagascar, the fourth largest islands in the world, is renowned for its high biological and ecological diversity, and is characterised by its high abundance of endemic species. Madagascar is one of the poorest nations in the world and very dependant on the resources the natural environment provides. As a result, conservation and development work is of paramount importance as efforts are made to preserve an environment under pressure from non-sustainable exploitation. Frontier Madagascar is in the process of carrying out baseline survey work in the northern tip of coastal Madagascar, the Antsiranana region, in an effort to provide biological and resource utilisation data for the preparation of sustainable management initiatives for the region.

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Abstract

Avian diversity was measured in two forest fragments in the Ampombofofo region northern Madagascar. The fragments shared many physical characteristics but differed in terms of vegetation species composition, one fragment resembled natural forests while the other exhibited a high degree of anthropogenic alteration of the arboreal species composition. Avian species diversity was low in both fragments and composed mainly of generalist species. No significant differences were found between the avian species composition in the two fragments, suggesting that the forest fragments in the Ampombofofo region of northern are of little value to avian conservation. If the avian species diversity is to be increased within this area, a programme of reforestation needs to be implemented.

Key words: Bird diversity, human disturbance, dry deciduous forest, Madagascar

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Contents

1. Introduction

Madagascar is well known for its high levels of endemism across virtually all taxa. The avifauna is no exception with 51% of breeding species being endemic (Hawkins and Goodman, 2004). However, Madagascar is also famed for its large scale deforestation. Recent rates of forest loss have been relatively low by comparison with other tropical countries; the 1990-1995 deforestation rate was estimated at 0.9% p.a., Brookes *et al.* 2002. However this is predominantly due to high historical rates leaving very low current forest cover (Harper *et al.* 2007). Encroachment into remaining forests by burning, grazing and forestry is evident, even where protection strategies exist (e.g. Hawkins 1990, D'Cruze *et al*. 2006). Clearance strategies such as these are widely recognized for detrimentally affecting species composition for all fauna, particularly due to the resultant loss in canopy cover (e.g. Wilcox 1988; Brook *et al*. 2003; Scott *et al.* 2006).

It is estimated that 97% of Madagascar's dry deciduous forests have been lost, with few remaining areas exceeding 800 ha (Smith 1997). The paucity of large tracts of dry forest means that it is increasingly important to examine smaller forest fragments in order to assess their potential as islands of habitats and stepping stones between larger remaining patches. The area investigated in this report has substantial evidence of human degradation, as is the case in much of northern Madagascar. Hawkins and Goodman (2004) state that species diversity is poorer in western dry forests compared to other forests and propose secondary dry forests of similar composition to primary dry forests, are able to support a similar species structure even when affected by degradation. However, recent studies of dry forests by D'Cruze and colleagues, among others, have highlighted both their importance for reptile species, and our relative lack of knowledge about these ecosystems (e.g. D'Cruze *et al*. 2006; 2008; Megson *et al*. 2009).

Several recent in-depth studies have investigated the effects of landscape degradation on bird species diversity in Madagascar (e.g. Hino 2002; Watson *et al.* 2004; Watson *et al.* 2005; Scott *et al.* 2006). The majority of these studies concentrate on the southern areas of Madagascar; there has been much less of a focus on the northern dry-deciduous forests. However, Ganzhorn *et al.* (2001) suggest that the most fragmented and degraded ecosystems in Madagascar are the western dry deciduous forests, eastern littoral forests and the central woody formations, and that these forests may be unable to support healthy populations beyond 2020-2040. Watson *et al.* (2004; 2005) concluded that the littoral

forests of eastern Madagascar act as important transitional zones between spiny and humid habitats meaning that the degree of larger scale degradation and species loss to other surrounding forests is affected by the sensitivity of these transitional forests. This increasing fragmentation, resulting in restricted dispersal processes (Bodin and Norberg 2007), is therefore a primary concern to the protection of Madagascan forests. Habitat corridors are valuable conservation tools for the sustainability of fragmented environments by providing natural connectivity between forests (e.g. Beier and Noss 1998). Whether fragments of dry northern forest habitat play a role in the transition of migratory species between larger habitat patches is unknown. It may, therefore, be important to protect such areas for future biodiversity conservation, and is vital to understand the dynamics of species use of these fragments.

Birds are commonly used as indicator species due to their sensitivity to changes in their environment and ease of survey. Numerous endemic bird species are restricted to specific ecosystems and although several are capable of surviving in primary and certain secondary forest fragments, research shows 'most will not survive if these refuges are diminished much further' (Hawkins 1990: 96). The decrease of bird diversity can have a severe negative influence in terms of both biodiversity and ecosystem functioning, by limiting fertilization and dispersal processes within the forest (e.g. Chapin *et al.* 2000; Fischer *et al.* 2007).

This report investigates how avian species diversity differs between similarly sized forest fragments of differing composition and levels of degradation. By assessing the diversity of species in highly degraded and more naturalistic forest fragments we aim to test whether the few forest fragments which still persist in unprotected areas of Madagascar can play an important role in the conservation of avian communities.

2. Study Area and Methods

The study site was located in remaining forest fragments was surrounding the small village of Ampombofofo, located 12km north-east of the coastal village of Ambanilakely in northern Madagascar. Previously the area has received little scientific interest (but see D'Cruze *et al*. 2006; Megson *et al*. 2009; Frontier Madagascar 2007).

The annual rainfall in this area is seasonally dependent; the region receives up to 14mm of rainfall per day during the wet season (December to April), which decreases to 1mm per day during the dry season (July average; Jury 2003). Cyclones are frequent throughout the wet season with temperatures reaching up to 31°C (average 28°C). Geologically the region is dominated by sandstone consisting of large areas of unconsolidated sands (Du Puy and Moat 1993; 2003).

Point counts were conducted using the techniques of Bibby *et al.* (1992) as a standard methodology which has been employed in previous Madagascan avifaunal studies (e.g. Watson *et al.* 2004). Point counts were conducted twice daily, between 05:00–09:00 and 15:00–18:00. Strong winds and rainy days were avoided. Five point counts were conducted approximately 100 m apart along transects through each fragment. When possible zebu tracks, natural courses and paths were followed to minimize disturbance. Counts lasted ten minutes at each point and birds encountered within a 25 m radius were included in the survey data. Acoustic data were also used, where applicable, to identify species. Identifications were made according to a range of field guides including Morris and Hawkins (1998), Sinclair *et al.* (2006) and Williams and Arlott (1980).

Two forest fragments of approximately similar size were repeatedly surveyed over a six-month period between July 2007 and December 2007. Ten surveys, comprising five 10-minute point counts, were carried out in each fragment. Habitat data were collected at each of the bird point count sites. The percentage of vegetation cover was estimated and a 10m x 10m quadrat area measured within each quadrat canopy height. Where possible the dominant species (any species that comprises 30% or more of the total of each plot) were identified to genus level. Each fragment was placed into one of two categories, based on the predominant habitat type. The ‘native’ forest fragment was dominated by tree species native to the northern dry forests of Madagascar including *Pachypodium* spp., *Dracaena* sp., *Euphorbia* sp., *Acacia* sp., *Adansonia* sp. and *Norohonia* sp. The ‘degraded’ forest fragment showed greater levels of anthropogenic disturbance and were dominated by introduced species such as *Anacardiaceae manifera* (mango) and *Lantana* sp.

Birds were classified into habitat-use guilds using methods suggested by Hawkins and Goodman (2004), whereby those birds with abundances at least twice as great in the natural forest fragment as in the ‘degraded’ fragment were classified as ‘true’ forest species. For the purpose of this study bird species exhibiting high abundance in both habitat types were classified as ‘common’. Those found in

low abundances in either habitat type, were classified as ‘rare’ (defined as those species observed in less than 10% of the total number of surveys).

Jackknife estimates were used to obtain estimates of species richness within the sample areas (see McCune and Grace, 2002). The estimations are not assumed to be true species richness due to inexperience on the part of the recorder, however, since the same individual collected all the data, the estimates can be used as relative measures of diversity. First-order estimates have greater accuracy on smaller data sets while second-order estimates are more accurate when used with larger samples. The second-order estimate can be smaller than the observed number of species where no species occur at only one site, but many species occur at just two sites. Unlike many species richness estimates the jackknife estimation is not affected by underlying numerical distributions (Magurran 1988). Two-sample t-tests were applied to compare species richness in the ‘native’ and ‘degraded’ fragments.

3. Results

A total of 73 species were identified in total from the region (appendix 2), but only thirty species were encountered during the six point counts (table 1). In the natural forest fragments a total of 25 species were recorded, whereas 26 species were recorded in the ‘degraded’ fragment. The mean number of individuals per survey was 10.9 in the ‘native’ forest and 21.0 in the ‘degraded’ forest, with an average of 2.5 species per survey collected in the ‘native’ forest fragment and 2.9 in the ‘degraded’ fragment. Just four species were recorded solely in the ‘native’ fragment: long-billed greenbul (*Phyllastrephus madagascariensis*), Madagascar malachite kingfisher (*Apus barbatus*), Madagascar pygmy kingfisher (*Ispidina madagascariensis*) and the Madagascar scops owl (*Otus rutilus*). Five species were observed to occur solely in the ‘degraded’ fragment: Madagascar red fody (*Foudia madagascariensis*), Namaqua dove (*Oena capensis*), Madagascar buzzard (*Buteo brachypterus*), Madagascar bush lark (*Mirafra hova*) and the dimorphic egret (*Egretta dimorpha*). Interestingly, the buzzard and fody species are generally known to prefer primary forest habitats (Morris and Hawkins 1998). Several further species which were found in the ‘native’ fragment are not normally described as primary forest dwellers; these include Madagascar buttonquail (*Turnix nigricollis*), Madagascar green pigeon (*Treron australis*), Madagascar bee-eater (*Merops superciliosus*), Madagascar nightjar (*Caprimulgus madagascariensis*), pied crow (*Corvus albus*) and sakalava weaver (*Ploceus sakalava*). These occurrences suggest that the primary forest is used by secondary forest dwelling species and vice versa.

Table 1. Species observed during study. Habitat preference given by Morris and Hawkins (1998) and classification of rare/common species according number of occurrences in surveys. Bold presence/absence data shows those species occurring in unexpected habitat according to Morris and Hawkins (1998). Habitat preferences: PF – primary forest; SC – secondary forest; Sc – scrubland; O – open grassland habitats; I – inhabited areas

Species	Common name	Primary	Secondary	True forest species	Habitat preference	Rare/common
Egretta dimorpha	Dimorphic Egret	N	Y	N	O	Rare
Buteo brachypterus	Madagascar Buzzard	**N**	Y	N	PF SF	Common
Turnix nigricollis	Madagascar Buttonquail	**Y**	Y	Y	SF	Common
Streptopelia picturata	Madagascar Turtle dove	Y	Y	Y	PF SF	Common
Oena capensis	Namaqua Dove	N	Y	N	O	Rare
Treron australis	Madagascar Green Pigeon	**Y**	Y	Y	SF	Common
Cuculus rochii	Madagascar Lesser Cuckoo	Y	Y	Y	PF SF	Common
Coua cristata	Crested Coua	Y	Y	N	PF SF	Common
Centropus toulou	Madagascar Coucal	Y	Y	Y	PF SF	Common
Otus madagascariensis	Madagascar Scops Owl	Y	**N**	Y	PF SF	Common
Caprimulgus madagascariensis	Madagascar Nightjar	**Y**	**Y**	N	O	Common
Alcedo vintsioides	Madagascar Malachite Kingfisher	Y	**N**	Y	PF SF	Rare
Ispidina madagascariensis	Madagascar Pygmy Kingfisher	Y	**N**	N	PF SF	Rare
Merops superciliosus	Madagascar Bee-eater	**Y**	**Y**	N	O	Common
Upupa marginata	Madagascar Hoopoe	Y	Y	Y	PF SF	Common
Mirafra hova	Madagascar Bush lark	N	Y	N	O	Rare
Hypsipetes madagascariensis	Madagascar Bulbul	Y	Y	N	PF SF	Common
Copsychus albospecularis	Madagascar Magpie Robin	Y	Y	Y	PF SF	Common
Newtonia Brunneicauda	Common Newtonia	Y	Y	N	PF Sc	Common
Neomaxis tenella	Common Jery	Y	Y	N	PF SF	Common
Terpsiphone mutate	Madagascar Paradise Flycatcher	Y	**Y**	Y	PF	Common
Nectarinia souimanga	Souimanga Sunbird	Y	Y	N	PF SF	Common
Vanga curvirostris	Hook Billed Vanga	Y	Y	N	PF SF Sc	Common
Falculea palliate	Sickle Billed Vanga	Y	Y	N	PF	Common
Leptopterus chabert	Charberts Vanga	Y	**Y**	N	PF SF Sc	Common
Dicrurus forficatus	Crested Drongo	Y	Y	N	PF SF	Common
Ploceus sakalava	Sakalava Weaver	**Y**	**Y**	N	O I	Rare
Foudia madagascariensis	Red Fody	**N**	Y	N	PF SF	Common
Hypsipetes madagascariensis	Long Billed Greenbul	Y	**N**	Y	PF SF	Rare
Corvus albus	Pied Crow	**Y**	**Y**	N	O I	Common

Using Hawkins and Goodman's (2004) method, eleven species may be classified as true forest species (Table 1). Rare species (those found in less than 10% of surveys) are also given, however these tend to highlight those of low abundances rather than true rare species.

First order jackknife estimates suggest the observed species richness observed in the 'native' fragment was relatively low (25.3 species estimated, 21 species observed) but the observed and predicted results for the 'degraded' forest are very similar (26.6 species expected and 27 observed). The differences in observed species richness between the two sites were not significantly different ($t = 1.314$, $df = 1$, $p = 0.414$).

4. Discussion

The two fragments studied were chosen to resemble each other in terms of physical characteristics such as tree density, canopy cover, size and aspect. The major difference between the two fragments lay in the vegetational species composition. The vegetation in the 'native' fragment resembled that assumed to be the natural forest community, whereas the 'degraded' fragment had been highly modified by the anthropogenic introduction of non-native tree species.

True forest species, as categorised by Morris and Hawkins (1998; table 1) were not well represented in these surveys. Madagascar paradise flycatchers (*Terpsiphone mutate*) were observed in both the native and degraded fragments, whereas Morris and Hawkins (1998) indicate they are usually confined to primary forests. Madagascar nightjars, pied crows, sakalava weavers and Madagascar bee-eaters were also observed in both the native and degraded fragments, whereas they are usually characterised as inhabitants of open rather than forested areas (Morris and Hawkins 1998).

No significant differences were observed between the two fragments in terms of species richness. As the two fragments are so similar, it appears as though there has either been no loss after local scale degradation of the habitat or that the majority of loss has already occurred in both fragments, with both now only being utilised by mainly generalist species. Large scale regional degradation is possibly responsible for the alteration of the natural composition of bird species in the fragment which more closely resembled the natural vegetation community of the area. The fragment was considerably less diverse than other nearby larger tracts of primary forests such as Montagne d'Ambre (ANGAP species

list, personal communication), and lacked true dependant forest species such as vasa parrots (*Coracopsis* spp.). This suggests that current connectivity found in the Ampombofofo region is not sufficient to maintain subpopulations of forest specialist bird species in relatively natural forest fragments.

Species diversity was low. This is likely to be due, in part, to the sampling effort missing rarer species. However, generally, it seems that the area has already suffered species loss from degradation and is now unable to support true forest or specialised species because of the effects of degradation. Hawkins and Goodman (2004) estimate that only 15% of Madagascan terrestrial species are capable of surviving in open habitats, supporting the findings of this study; that species diversity is low in 'degraded' habitats.

5. Conclusions

The two fragments, differing predominantly only in vegetation species composition, showed no significant difference in the bird diversities they supported. The two fragments shared common, non-specialist species which are able to adapt to general conditions in forest structure, and thrive within a habitat matrix. With the lack of true, specialised species in both forest areas, it would be unexpected that these species would be vulnerable to continued forest degradation; primarily because the majority of species have already been lost from the area. Therefore, continued degradation is unlikely to cause any major loss of species in the native forest fragments.

The lack of governmental protection, in addition to the remaining fragments of forest being heavily relied on as a source of food and timber by local communities, means future reforestation does not look promising in this region. This area is likely to become more degraded and lose any remaining true forest and endemic species which will contribute to a larger national scale loss in diversity if degradation rates continue across the country. If the avian species diversity is to be increased within this area, a programme of reforestation needs to be implemented.

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Appendix 1. Complete species list of birds observed during MGF study in Ampombofofo (including species encountered during point counts and general observations). *species encountered during the surveys used for this study

Species	Vernacular Name
Phaeton lepturus	White-tailed Tropicbird
Nycticorax nycticorax	Black-crowned Night Heron
Ardeola idea	Madagascar Squacco Heron
Bubulcus ibis	Cattle Egret
Egretta dimorpha	Dimorphic Egret*
Ardea cinerea	Grey Heron
Dendrocygna viduata	White-faced Whistling Duck
Macheiranphus alcinus	Bat Hawk
Buteo brachypterus	Madagascar Buzzard*
Falco newtoni	Madagascar Kestrel
Numida meleagris	Helmeted Guineafowl
Turnix nigricollis	Madagascar Buttonquail*
Dryolimnas cuvieri	White-throated Rail
Rostratula benghalensis	Greater Painted Snipe
Himantopus himantopus	Black-winged Stilt
Dromas ardeola	Crab Plover
Glareola ocularis	Madagascar Pratincole
Charadrius pecuarius	Kittlitz's Plover
Charadrius tricollaris	Three-banded Plover
Charadrius marginatus	White-fronted Plover
Charadrius leschenaultia	Greater Sand-plover
Pluvialis squatarola	Grey Plover
Numenius phaeopus	Whimbrel
Actitis hypoleucus	Common Sandpiper
Arenaria interpres	Ruddy Turnstone
Sterna caspia	Caspian Tern
Sterna bengalensis	Lesser Crested Tern
Streptopelia picturata	Madagascar Turtle Dove*
Oena capensis	Namaqua Dove*
Treron australis	Madagascar Green Pigeon*
Agapornis cana	Grey-headed Lovebird
Cuculus rochii	Madagascar Lesser Cuckoo*
Coua cristata	Crested Coua*
Centropus toulou	Madagascar Coucal*
Otus madagascariensis	Madagascar Scops Owl*
Caprimulgus madagascariensis	Madagascar Nightjar*
Apus barbatus	African Black Swift
Alcedo vintsioides	Madagascar Malachite Kingfisher*
Ispidina madagascariensis	Madagascar Pygmy Kingfisher*
Merops superciliosus	Madagascar Bee-eater*
Euroystomus glaucurus	Broad-billed Roller
Upupa marginata	Madagascar Hoopoe*
Mirafra hova	Madagascar Bush Lark*
Phedina borbonica	Mascarene Martin

Species	Vernacular Name
Hirundo rustica	Barn Swallow
Motacilla flaviventris	Madagasar Wagtail
Hypsipetes madagascariensis	Madagascar Bulbul*
Bernieria madagascariensis	Long-billed Tetraka
Copsychus albospecularis	Madagascar Magpie-robin*
Newtonia Brunneicauda	Common Newtonia*
Cisticola cherina	Madagascar Cisticola
Neomaxis tenella	Common Jery*
Terpsiphone mutate	Madagascar Paradise Flycatcher*
Nectarinia souimanga	Souimanga Sunbird*
Vanga curvirostris	Hook-billed Vanga*
Falculea palliate	Sickle-billed Vanga*
Leptopterus chabert	Chabert's Vanga*
Cyanolanius madagascariensis	Blue Vanga
Dicrurus forficatus	Crested Drongo*
Acridotheres tristis	Common Mynah
Ploceus sakalava	Sakalava Weaver*
Foudia madagascariensis	Madagascar Red Fody*
Lonchura nana	Madagascar Mannikin
Sula leucogaster	Brown Booby
Egretta ardesiaca	Black Egret
Dendrocygna bicolor	Fulvous Whistling Duck
Amaurirnis olivieri	Sakalava Rail
Numenius arquata	Eurasian Curlew
Coracopsis nigra	Lesser Vasa Parrot
Hypsipetes madagascariensis	Long-billed Greenbul*
Corvus albus	Pied Crow*
Phyllastrephus apperti	Appert's Greenbul
Coracina cinerea	Cuckoo Shrike