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Note and record

Kimboza Forest Reserve, Tanzania: an important cold season refugium for altitudinal migrating birds

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Introduction

Altitudinal migration of birds is defined as movements of individuals from higher to lower altitudes and *vice versa* due to different causes such as variations in food availability (Chaves-Campos, Arévalo & Araya, 2003; Boyle, 2010), changes in weather (Boyle, Norris & Guglielmo, 2010) or trade-offs between predation and survival (Boyle, 2008). Altitudinal migrations of birds have been reported to exist for most major mountain ranges of the world (Mcguire & Boyle, 2013). In Africa, altitudinal migration of birds has been documented by several authors (e.g. West Africa: Stuart, 1986; south-central Africa: Dowsett-Lemaire, 1989; Southern Africa: Oatley, 1982; Johnson & Maclean, 1994; East Africa: Stuart, 1983; Stuart *et al.*, 1993; Burgess & Mlingwa, 2000; Werema, 2015a).

Several studies have discussed the aspect of altitudinal migration of birds in the Eastern Arc Mountains (Stuart, 1983; Stuart *et al.*, 1993; Burgess & Mlingwa, 2000; Werema, 2015a). However, relatively little is known for some areas, particularly in the isolated forest fragments that are found at the lower altitudes. This note presents findings on the effects of season on understorey bird assemblages in Kimboza Forest Reserve, an isolated forest fragment located about 12 km from Uluguru Mountains. The main emphasis is on the aspect of altitudinal migration because no quantitative studies on altitudinal migratory birds covering different seasons are available in this forest reserve.

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Methods

Data were collected in Kimboza Forest Reserve (7°00′S and 37°48′E), a lowland forest found in the eastern foothills of the Uluguru Mountains, Tanzania (Fig. 1). The reserve is isolated and not connected with the higher elevation forests and is found *ca.* 12 kilometres from the lowest border of the Uluguru Nature Reserve (Fig. 1). It is a small *ca.* 385 ha (Rodgers *et al.*, 1983) semi-deciduous lowland forest located between 180 and 500 m above sea level at the lowest and highest points.

In the study area, most rain falls during April and May and is accompanied by decrease in temperatures leading to a relatively cooler season between April and September, usually referred to as 'the cold season'. Temperatures are relatively higher between October and March, a period referred to as 'the hot season' (Werema, 2015b).

The study was conducted between 2005 and 2011 at sites S1 and S2 using mist netting in two sessions during the cold and hot seasons (Fig. 1). Mist netting was conducted at S1 in May and August 2005 during the cold season and in November 2005 and February 2006 during the hot season (hereafter first mist netting session). At S2, mist netting was conducted in July 2010 and January 2011 during the cold and hot seasons, respectively (hereafter second mist netting session). At each site during each mist netting session, the nets were erected for 36 daylight hours and operated from dawn (0600 h) to dusk (1800 h) for three consecutive days. Mist netting effort was 6480 metre-net hours during each season and at each site.

Data from the two mist netting sessions were pooled for each of the corresponding cold and hot seasons. The birds were grouped into two categories: migrants and nonmigrants (Burgess & Mlingwa, 2000; Werema, 2015a). A chi-square test (Yates corrected) was used to assess whether there were differences in captures of individuals between seasons. To assess the diversity of the understorey avian community, species diversity (H') during each

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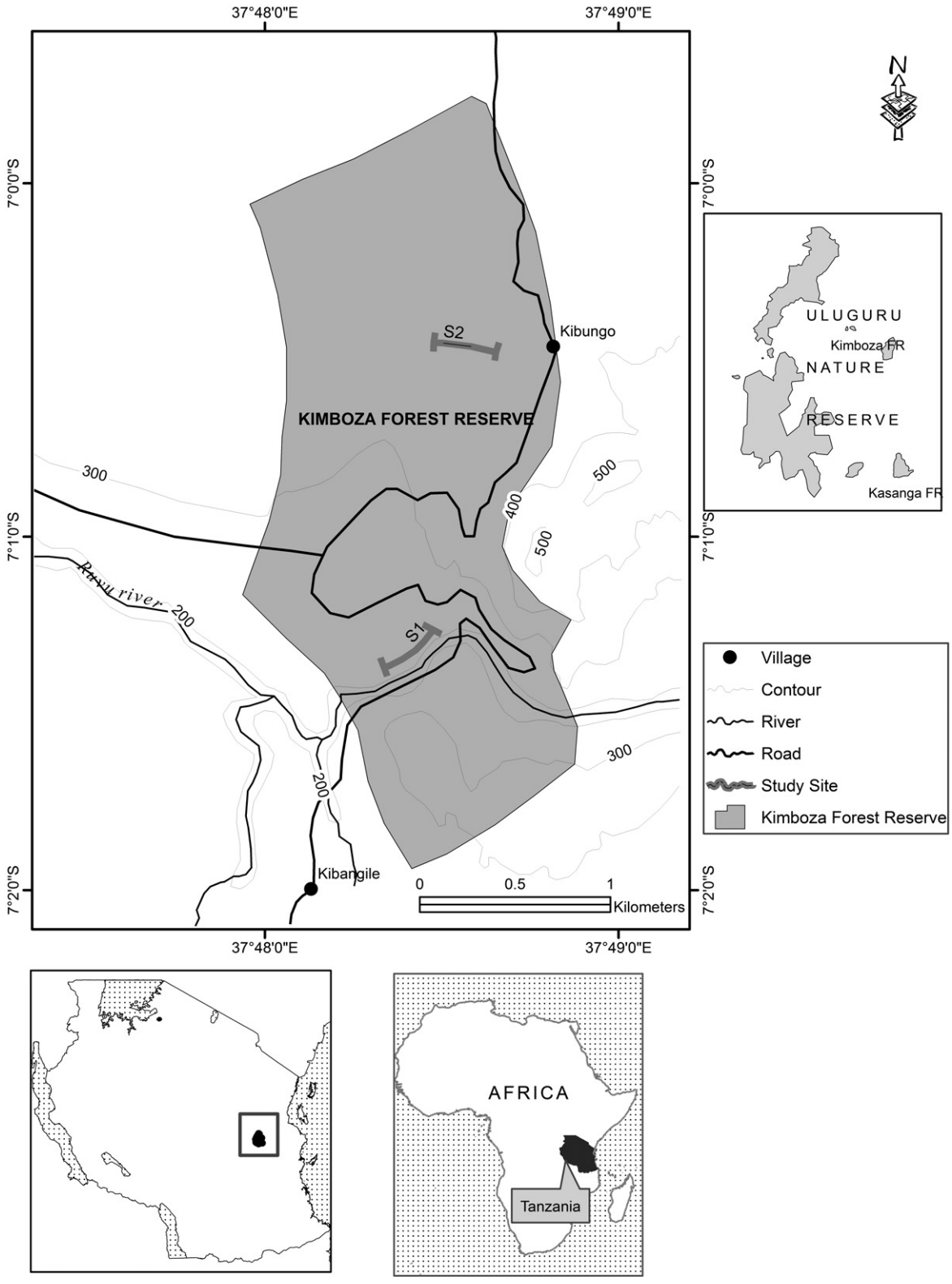


Fig 1 Location of Kimboza Forest Reserve (S1 and S2 are study sites)

season was calculated using the Shannon–Wiener index of diversity (Magurran, 1988). A t-test was used to assess whether there were seasonal differences in species diversity between cold and hot seasons (Hutcheson, 1970). This was carried out using a software package, PAST (Hammer, Harper & Ryan, 2001). The Z statistic was used to assess the proportion of altitudinal migrants during each season. Throughout this note species, nomenclature follows Stuart & Jensen (1985).

Results and discussion

In total, 218 individuals of 27 species were mist netted (Table 1). There were no significant differences in number of captures of birds ($\chi^2 = 0.11$, df =1, $P > 0.5$) and diversity between hot season ($H' = 2.538$) and cold season ($H' = 2.469$) (t = 0.555, df = 215.84, $P > 0.5$). When altitudinal migrants were analysed separately (i.e. by comparing data for only migrants between the two seasons), the number of captures of the birds ($\chi^2 = 19.34$, df = 1, $P < 0.001$) and diversity (cold season: $H' = 1.646$; hot season: $H' = 0.787$; t = 4.93, df = 24.06, $P < 0.01$) were significantly higher during the cold season than in the hot season. Of the mist-netted individuals captured during the cold season, 46.4% were of species which are known altitudinal migrants. In contrast, during the hot season, of the 106 individuals mist netted, the contribution of the migrants (to the total individuals mist netted) was only 14.2% (Fig. 2). The proportion of migrants was significantly higher during the cold season than in the hot season ($Z = 5.16$, $P < 0.0001$).

The higher proportion of migrants during the cold season suggests that more individuals of species that make altitudinal movements moved to Kimboza Forest Reserve during the cold season than in the hot season. This was further supported by the higher abundance and diversity of migrants during the cold season. These findings mirror those of Burgess & Mlingwa (2000), Cordeiro *et al.* (2006) who reported higher abundances of migrants in low-altitude forests during the cold season than in the hot season within the Eastern Arc Mountains. Elsewhere, similar findings have been reported in Natal, South Africa (Johnson & Maclean, 1994), south-central Africa (Dowsett-Lemaire, 1989) and Costa Rica (Boyle, Norris & Guglielmo, 2010).

Some species such as Red-capped Robin Chat *Cossypha natalensis* and Green-backed Twinspot *Mandingoa nitidula* had higher abundances during the hot season compared to the cold season. This could be interpreted to mean that when altitudinal migrants arrive to Kimboza forest, they do not enrich the community (in terms of species richness, total abundance and diversity) but rather replace some of the nonmigrants. This could be due to local movements of some species that are unrelated to elevation. For example, *C. natalensis* is a well-known partial migrant, usually rare or absent in certain seasons (Keith, Urban & Fry, 1992)

Table 1 Understorey birds mist netted at Kimboza Forest Reserve. The number of birds is based on equal sampling effort during each season. * = altitudinal migrants

Species	Season	
	Cold season	Hot season
Accipiter tachiro African Goshawk	2	0
Turtur tympanistria Tambourine Dove	0	2
Apaloderma narina Narina Trogon	0	1
Apaloderma vittatum Bar-tailed Trogon*	4	0
Ispidina picta Pygmy Kingfisher	2	5
Smithornis capensis African Broadbill	3	0
Dicrurus ludwigii Square-tailed Drongo	1	2
Trichastoma rufipennis Pale-breasted Illadopsis	0	1
Andropadus milanjensis Stripe-cheeked Greenbul*[E]	2	0
Andropadus virens Little Greenbul*	14	5
Nicator chloris Nicator	0	6
Phyllastrephus cerviniventris Grey-olive Greenbul	2	3
Phyllastrephus debilis Tiny Greenbul	6	9
Phyllastrephus fischeri Fisher's Greenbul	2	3
Phyllastrephus flavostriatus Yellow-streaked Greenbul	1	4
Alethe fuelleborni White-chested Alethe*	13	1
Cossypha natalensis Red-capped Robinchat	11	27
Neocossyphus rufus Red-tailed Ant Thrush	4	1
Pogonocichla stellata White-starred Forest Robin*	10	0
Camaroptera brachyura Grey-backed Camaroptera	1	2
Elminia albonotata White-tailed Crested Flycatcher*	1	0
Terpsiphone viridis Paradise Flycatcher	1	0
Trochocercus cyanomelas Crested Flycatcher	2	3
Nectarinia olivacea Olive Sunbird*	8	9
Hypargos niveoguttatus Peter's Twinspot	21	7
Mandingoa nitidula Green-backed Twinspot	1	13
Pyrenestes minor Lesser Seed-cracker	0	2
Total number of individuals	112	106
Total number of species	22	20
Species diversity	2.538	2.469

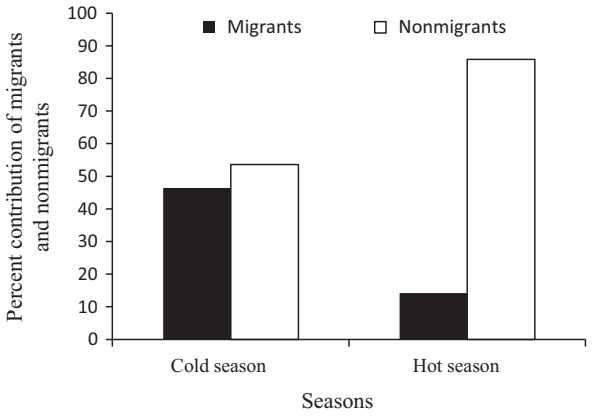


Fig 2 Proportion of altitudinal migrants and nonmigrants in understorey bird community during the cold and hot seasons

and *M. nitidula* has been known to make local movements (Fry & Keith, 2004).

The findings of this study suggest that Kimboza Forest Reserve is an important cold season refugium for some birds which make altitudinal migrations between low and high altitudes in the Uluguru Mountains.

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