WET SEASON BIRD SPECIES RICHNESS AND DIVERSITY ALONG URBAN-RURAL GRADIENT IN MOROGORO MUNICIPALITY AND SURROUNDING AREAS, TANZANIA

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ABSTRACT

This study examined the variation in diversity and distribution of avian species across an urban–rural gradient during the wet season in Morogoro municipality and its surroundings. A total of 2547 individuals comprising 86 species belonging to 11 orders and 37 families were recorded across urban-rural habitats. The highest (65) species richness was recorded in rural zone, followed by sub-urban zone (56) and Morogoro core urban zone, the lowest (29). Similarly, species diversity was highest in rural zone (H'= 3.107) and lowest in Morogoro core urban (H'= 2.021), suggesting that increasing urbanization is adversely impacting bird communities across the rural-urban stretch. No significant difference in species diversity was detected between rural and sub-urban zones, but relative abundance of birds differed between the zones. Further, diverse bird guilds were recorded varying across the urban-rural gradients indicating the area's conservation importance. Increasing urban development severs more suitable habitats with dire consequences on the survival of disturbance-sensitive bird species. These results underpin the need for considering integrated avifaunal conservation strategies and are important for planning local avitourism activities and to protect remaining natural habitats in the municipality.

Key words: bird guilds; bird richness; species diversity; urban habitats; urban-rural gradients; Morogoro Tanzania

INTRODUCTION

Urban environments are generally areas characterized by a growing human population, pollution, and conversion of natural habitats into built-up areas (Marzluff 2001). The rapid growth and increase in human population in urban areas has resulted in lowering the quality of natural ecosystems. Urbanization is recognized as one of the greatest threats to biodiversity throughout the world (Savard *et al.* 2000, Grimm *et al.* 2008). The activities associated with this threat often lead to conversion of natural areas (e.g. forests, and agricultural land for expansion of human settlements) into urban and sub-urban environments (Cobbinah and Amoko 2012). This renders alteration of the species composition, structure and functions of natural ecosystems (Rija *et al.* 2014; Grimm *et al.* 2008). As the urban sprawl increases, it leaves isolated patches of physical structures such as built dams and ponds as well as natural vegetation which contribute to biodiversity losses (Reale and Blair 2005). Despite increasing interests among urban ecologists in understanding effects of urbanization on biota including the avian community, still many studies have focused on developed countries leaving developing countries less

explored (Pauchard *et al*. 2006; McKinney 2008). This raises great conservation concern because of an ever increasing urban growth in most sub-Saharan countries (Cohen 2006) which is likely to pose severe effects on urban ecosystems (McKinney 2008; Rija *et al.* 2014). Many studies have documented the effect of urbanization on bird community (Marzluff 2001, Blair 2004, Devictor *et al.* 2007, Miller *et al*. 2003). These studies indicate that the urban setting which is normally highly developed has low native bird species diversity and richness but has high abundance of non-native bird species, although this pattern may differ in some areas (Marzluff *et al*. 2001, Chace and Walsh 2006). While urbanization may overall increase total bird abundance in urban cores, it appears that only a few species dominate (Savard *et al.* 2000).

Morogoro municipality is increasingly expanding partly due to its location connecting other regions in the country and bordering countries and due to influx of immigrants. The area is emerging as a major hub for urban activity (Rija *et al.* 2014). Increase in land use activities such as small scale business enterprises, gardening and establishment of new settlements is commonplace and is perceived to threat sustainable natural urban ecosystem (Said 2012). A recent study shows high turnover in native plant species diversity due to species introduction by humans into the city (Rija *et al.* 2014). This potentially impact on other taxa negatively. Most bird species are influenced by the composition of the vegetation that forms a major element of their habitats. For example, native vegetation has been observed to correlate with native bird species while exotic vegetation is linked to a few native species (Ikin *et al*. 2013). Therefore changes in a particular bird species habitat due to vegetation alterations may lead to a species emerging, increasing or decreasing in number, or disappearing (Lee and Rotenberry 2005).

Despite a notable effect of urbanisation on the plant community of Morogoro municipality and its vicinity (Rija *et al.* 2014), little is known of the cascading effect on the animal species such as birds, inhabiting urban habitats. The objective of this study was to assess bird species diversity, abundance and distribution along an urban-rural gradient, in Morogoro municipality. Previous studies show that the municipality is increasingly impacted by non-native plant species and clearance of trees (Rija *et al.* 2014; 2013). Specifically, the study aimed at answering the questions of how bird richness changes across the urban-rural gradients and whether urbanization intensity influences abundance and distribution of the bird species across the urban-rural gradient. The feeding and habitat guilds of the birds were also explored in order to understand the conservation value of urban areas for the bird communities during the wet season.

MATERIALS AND METHODS

Study Area

The study was conducted in Morogoro municipality which is located at about 200 km west of Dar es Salaam city between latitudes 5º 00' and 7º 40' S and longitudes 37º 10' and 38º 33' E. The municipality has a population of approximately 600,000 people (Mayor-Morogoro municipality pers. com, 2012) in an area of more than 65 km^2 at the foot of the Uluguru Mountains (Rija *et al.* 2014). The area experiences bimodal pattern characterized by short rains from November to January and long rains during March to May. The annual rainfall ranges from 600 mm to 1000 mm. The mean monthly temperature varies between 21°C and 27°C. The vegetation cover comprises a mixed natural and non-native species assembled as a result of development activities (Rija *et al.* 2014). Further, based on the

development plan available for this municipality, three distinct zones were identified (hereby named urban zones) namely core-urban , sub-urban and peri-urban corresponding to the 'high density', 'medium density' and 'low density area' categories being used by Morogoro Municipal Council when allocating land properties to the urban residents (Rija *et al*. 2014). In this study, core-urban, sub-urban (Falkland and adjacent areas) and peri-urban (Mzinga and surrounding areas) were used to study composition and diversity of bird communities.

Research Design and Bird Survey

Bird assessment was conducted in March 2013 in the three zones using the Mackinnon list technique (Mackinnon and Phillips 1993). The Mackinnon list technique is a standardised rapid assessment technique for tropical bird community assessment that provides an index of relative abundance and can be used to calculate species discovery curve. This technique has previously been used to survey bird communities in the east and southeast coastal forests of Tanzania (Rija *et al*. Unpublished; Jensen *et al*. 2005). With the Mackinnon list technique, all bird species observed and heard are recorded as the researcher slowly and carefully walks along a transect line or trail in different habitats and identifies birds. The names of sighted or heard birds are listed non-repetitively until the list accumulates a predetermined number of species. In this study, 15 species lists which is the recommended minimum were used (Mackinnon and Phillips 1993). The technique allows for the list to serve as independent sampling units (thus can then be pooled together for analysis) where in any list, a species cannot be repeated, but on subsequent list allowing more new species to be collected. Mackinnon lists were compiled while walking through different habitats, stopping at regular intervals to search out, observe and record individual species or flocks of bird. Identification of birds during field sampling was done with the aid of binoculars (8×40) and field guides (Stevenson and Fanshawe 2002, William and Arlott 1992). Also, overflying birds were included in the list when correctly identified. The two study sites (rural and sub-urban zones) were visited for 5 consecutive days and one site (core-urban zone) was visited for 5 non-consecutive days giving a total of 60 lists. Bird surveys were conducted between 0630 and 1230 hrs and from 1500 to 1800 hrs on days without rain allowing for more time to record bird across various habitat structures.

Data Analysis

The Shannon-Wiener Index of diversity, H' was used to calculate the diversity of species across the various habitats. Biodiversity Prover.2 programme was used to calculate species diversity values. Simpson index, S was used to calculate the dominance of species. Abundance of species in the various habitats was assessed as the total number of birds recorded in a particular site (total count per site). The distribution of species in the study sites was recorded as presence or absence of each species, determined by evenness. Relative abundance of species in the various study sites was assessed as the number of respective species per total number of species in a study site, i.e. the proportion of individual species relative to the total number of species in a site. Variations in relative abundance and diversity of species among the sites were examined using the Kruskal-Wallis test (Zar 1996) and followed by Dunn's multiple comparisons test between any two samples, if significant. For the analysis of feeding and habitat guilds, the proportion of each guild was computed to determine guilds composition. Differences in forest bird species between urban zones were also explored using a Kruskal-Wallis test.

RESULTS

Species richness and diversity

A total of 2547 individual birds comprising 86 species, belongings to 11 orders and 37 families were recorded across urban-rural habitats. The overall species richness of birds was highest (65 species) in rural zone followed by sub-urban (56 species); and Morogoro core urban zone which recorded the lowest (29) species richness. The dominant family in the study area was Ploceidae constituting 14.13% of the total species followed by Estrildidae (7.61%), Ardeidae (6.52%) and Sylviidae (5.43%). Passerines (Order Passeriformes) constituted 60.87% of all species with the highest number of observations. Thirteen migrant birds comprising eight Afrotropical migrants, three Palearctic migrants and one Afrotropica-Palearctic migrants were observed in the study area. Also, one endangered species, *Zoothera guttata* was recorded. Shannon-Wiener indices (H') of 3.107, 3.013 and 2.021 were calculated for the rural, sub-urban zone and Morogoro core-urban, respectively. There was significant difference of bird species diversity between the study urban zones (Kruskal-Wallis test, H=23.609; DF=2; $P = 0.0001$). The difference was between rural and core-urban zones (Dunn's test: $P<0.001$) and between sub-urban and core-urban zones ($P<0.01$) but not between rural and suburban zones (Dunn's test: $P>0.05$). Furthermore, species evenness was highest in sub-urban and rural zones (both E = 0.373) and lowest in core-urban zone (0.297).

Species Relative Abundance and Distribution

The most abundant species in rural zone was the Zanzibar red bishop (*Euplectes nigroventris*) with the highest Index of Relative Abundance (IRA) of 6.73%. Twenty nine (29) species had the lowest IRA of 0.337% each in this study zone. In contrast, sub-urban had the most abundant species, the common bulbul (*Pycnonotus barbatus*) with an IRA of 6.16%. Further, twenty one species in this study site each had the lowest IRA of 0.34%. On the other hand, three species including the common bulbul (*Pycnonotus barbatus*), Grey headed sparrow (*Passer griseus*) and House sparrow (*Passer domesticus*) from the core-urban were most abundant, each contributing 6.78% to the birds total. Nine species in this study zone had the lowest (0.339%) IRA. Each of these species appeared as single individual. Bird relative abundance was significant higher in the rural zone than in other two zones (Kruskal-Wallis test, H=21.169; DF=2; $P = 0.0001$).

Bird Ecological Composition

Bird guilds classification based on the habitats showed a diverse composition (Table 1). There was significant difference of forest bird species (F, f and s) in the study area (Kruskal-Wallis test, H= 9.912, $P = 0.002$). Dunn's Multiple Comparison test showed no significant variation in forest dependent bird species between rural and sub-urban habitats ($P>0.05$). Significantly large number was observed in rural than core urban zone ($P<0.01$). Also the sub-urban zone showed significantly more guilds than core urban zone ($P<0.05$).

Table 1: Summary of bird habitat guilds recorded in the study areas

	# of bird species & their % in three urban zones		
Habitat guilds	**Rural**	**Sub-urban**	**Core-urban**
Total number of species	65	56	29
Number of FF Species	0	0	0
% of FF species	0	0	0
Number of F Species	1	3	0
% of F species	1.53	5.35	0
Number of f Species	37	34	18
% of f species	56.92	60.71	62.06
Number of s Species	24	19	11
% of s Species	36.92	33.92	37.93

Key: FF, forest-specialist species; F, forest-generalist species; f, forest visitors; s, savannah or woodland species.

Bird Feeding Guilds

Birds in the study area were grouped into 13 different types of feeding guilds namely Insectivore (I), Carnivore (C), Carnivore/Frugivore/Insectivore (CFI), Carnivore/Insectivore (CI), Frugivore (F), Frugivore/Granivore (FG), Frugivore/Insectivore (FG), Granivore (G), Granivore/Insectivore (GI), Nectarivore (N), Nectarivore/Insectivore (NI), Omnivore (O) and Piscivore/Insectivore (PI). The Insectivore community was the most dominant feeding guild accounting for 40.22% of all the birds recorded. Majority of the feeding guilds (n = 12) were identified in rural zone including; I (37.5%), GI (15.28%), G (12.5%), PI (6.94%), CI and FI (5.56%). Other guilds in this zone were FG and O (each 4.17%), N and F (each 2.78%), CI and CFI (each 1.39%).

Similarly, in sub-urban zone 12 guilds were identified including I (40.68%), GI (15.25%), G (11.86%), FI, FG, and O (5.08%), PI, C, N and F (3.39%), CI and NI (1.69%). On the other hand, nine feeding guilds were identified in the core urban zone. These included; I (24.14%), GI (20.69%), O (17.24%), G (13.79%), C (10.34%); N, FI and FG (each 3.45%). There was a generally diverse bird community across the feeding guilds and habitat specialization in the study area (Table 2). The majority birds showed generality in the food habits.

Table 2: Bird species recorded showing habitat and feeding guilds in Mzinga, Falkland and Morogoro urban core area in Morogoro Municipality and its surroundings. Guild classification follows Hassan *et al.* (2013).

Order	Family	Common name	Species		urban study zones		
				Feeding guilds	rural	sub-urban	core urban
APODIFORMES	Apodidae	White-rumped Swift	*Apus caffer*	I		s	s
CHARADRIIFORMES	Jacanidae	African Jacana	*Actophilornis africanus*	I	s		
	Scolopacidae	Ruff	*Philomachus pugnax*	I (P)	s		
CICONIIFORMES	Ardeidae	Cattle Egret	*Bubulcus ibis*	PI (A)	f	f	f
		Little Egret	*Egretta garzetta*	PI	s	s	
		Great White Egret	*Ardea alba*	I	s		
		Common Squaco Heron	*Ardeola ralloides*	PI	s		
		Black-headed Heron	*Ardea melanocephala*	I	f	f	f
		Purple Heron	*Ardea purpurea*	PI	f		
COLIIFORMES	Coliidae	Speckled Mousebird	*Colius striatus*	FG	s	s	s
COLUMBIFORMES	Columbidae	African Mourning Dove	*Streptopelia decipiens*	FG	s	s	
		Ring-necked Dove	*Streptopelia capicola*	FG	f	f	
		Emerald-spotted Wood Dove	*Turtur chalcospilos*	F	f	f	
		Tambourine Dove	*Turtur tympanistria*	F	F		
CORACIIFORMES	Halcyonidae	Striped Kingfisher	*Halcyon chelicuti*	I	f		
		Brown-hooded Kingfisher	*Halcyon albiventris*	I	s	s	s
		Grey-headed kingfisher	*Halcyon leucocephala*	I (A)		f	
	Alcedinidae	Malachite Kingfisher	*Alcedo cristata*	I	f	f	
	Coraciidae	Lilac-breasted Roller	*Coracias caudata*	I	s		
	Meropidae	Little Bee-eater	*Merops pusillus*	I	s	s	
CUCULIFORMES	Cuculidae	White-browed Coucal	*Centropus superciliosus*	I	s	s	
		African Cuckoo	*Cuculus gularis*	I	f		
		Levaillant's Cuckoo	*Oxylophus levaillantii*	FI (A)	f		
		Black and white Cuckoo	*Oxylophus jacobinus*	I (A)	f		
FALCONIFORMES	Accipitridae	Long-crested Eagle	*Lophaetus occipitalis*	C	f	f	f
		Black Kite	*Milvus migrans*	C (AP)	f	f	f
		Shikra	*Accipiter badius*	C			f
	Falconidae	Common Kestrel	*Falco tinnunculus*	C (P)	f		
PELECANIFORMES	Scopidae	Hamerkop	*Scopus umbretta*	I	f	f	f
	Anhingidae	African Darter	*Anhinga rufa*	PI	s		
	Threskiornithidae	Sacred Ibis	*Threskiornis aethiopicus*	CI	f	f	
PICIFORMES	Capitonidae	Black-collared barbet	*Lybius torquatus*	FI		f	
		Spot-flanked Barbet	*Tricholaema lacrymosa*	F		f	
	Picidae	Cardinal Woodpecker	*Dendropicos fuscescens*	I		f	

Order	Family	Common name	Species		urban study zones		
PASSERIFORMES	Corvidae	Pied Crow	*Corvus albus*	O	f		f
		Indian House Crow	*Corvus splendens*	O	f	f	f
		White-necked Raven	*Corvus albicollis*	O			f
	Dicruridae	Fork-tailed Drongo	*Dicrurus adsimilis*	I		s	
	Estrildidae	Bronze Mannikin	*Lonchura cucullata*	G	f	f	f
		Green-winged Pytilia	*Pytilia melba*	G	s		
		African Firefinch	*Lagonosticta rubricata*	GI	f	f	f
		Common Waxbill	*Estrilda astrild*	G	f	f	
		Red-billed Firefinch	*Lagonosticta senegala*	GI	s	s	
		Red-cheecked Cordon-bleu	*Uraeginthus bengalus*	G	s	s	s
		Southern Cordon-bleu	*Uraeginthus angolensis*	G		s	s
	Fringillidae	African Citril	*Serinus citrinelloides*	G	f	f	
	Hirundinidae	Wire-tailed Swallow	*Hirundo smithii*	I	s		s
		Black Rough-winged Swallow	*Psalidoprocne holomelaena*	I		f	
	Malaconotidae	Brown-crowned Tchagra	*Tchagra australis*	I	s		
		Black-backed Puffback	*Dryoscopus cubla*	I	F	F	
		Tropical Boubou	*Laniarius aethiopicus*	I	f	f	
	Motacillidae	Grassland Pipit	*Anthus cinnamomeus*	I	s		
		African Pied Wagtail	*Motacilla aguimp*	I	s	s	s
	Muscicapidae	Ashy Flycatcher	*Muscicapa caerulescens*	I (A)	F	F	
		African Paradise Flycatcher	*Terpsiphone viridis*	I (A)		f	
	Nectariniidae	Scarlet-chested Sunbird	*Chalcomitra senegalensis*	N	f	f	f
		Variable Sunbird	*Cinnyris venusta*	N	f	f	
		Collared Sunbird	*Hedydipna collaris*	NI		F	
	Oriolidae	African Black-headed Oriole	*Oriolus larvatus*	FI	f		
		African Golden Oriole	*Oriolus auratus*	FI		f	
	Passeridae	Grey-headed Sparrow	*Passer griseus*	GI	s	s	s
		House Sparrow	*Passer domesticus*	GI		s	s
		Yellow-throated Petronia	*Petronia superciliaris*	GI	s		
	Ploceidae	Zanzibar Red Bishop	*Euplectes nigroventris*	GI	f	f	f
		Black-headed Weaver	*Ploceus melanocephalus*	O	f	f	f
		Black-winged Red Bishop	*Euplectes hordeaceus*	GI	f	f	f
		Grosbeak Weaver	*Amblyospiza albifrons*	GI		f	
		African Golden Weaver	*Ploceus subaureus*	GI	s	s	s
		Red-billed Quelea	*Quelea quelea*	G (A)	s		
		Golden-backed Weaver	*Ploceus jacksoni*	GI	f		
		Red-headed Quelea	*Quelea erythrops*	G (A)	s		
	Viduidae	Village Indigobird	*Vidua chalybeata*	G	s	s	s

Order	Family	Common name	Species		urban study zones		
		Pin-tailed Whydah	*Vidua macroura*	G	f	f	
	Pycnonotidae	Common bulbul	*Pycnonotus barbatus*	FI	f	f	f
	Sturnidae	Red-winged Starling	*Onychognathus morio*	O		f	f
	Sylviidae	Marsh Warbler	*Acrocephalus palustris*	I (P)	f		f
		African Reed Warbler	*Acrocephalus baeticatus*	I	f		
		Lesser Swamp Warbler	*Acrocephalus gracilirostris*	I		s	
	Cisticolidae	Rattling Cisticola	*Cisticola chiniana*	I		s	
		Croaking Cisticola	*Cisticola natalensis*	I		s	
	Turdidae	Spotted Morning-thrush	*Cichladusa guttata*	I	f	f	
		White-browed Robin-chat	*Cossypha heuglini*	I	f	f	
		Common Stonechat	*Saxicola torquata*	I	f		
		White-browed Scrub Robin	*Cercotrichas leucophrys*	FI	f		
	Zosteropidae	African Yellow White-eye	*Zosterops senegalensis*	I		f	

Key: I=Insectivore, C=Carnivore, CFI=Carnivore/Frugivore/Insectivore, CI=Carnivore/Insectivore, F=Frugivore, FG=Frugivore/Granivore, FI=Frugivore/Insectivore, G=Granivore, GI=granivore/Insectivore, N=Nectarinivore, NI=Nectarinivore/Insectivore, O=Omnivore, PI=Piscivore/Insectivore. Migrant status: A=Afro tropical, P=Palaearctic and AP=Afro tropical-Palaearctic migrant; conservation status: *=Endangered; FF = forest specialist species, F= forest generalist, f = forest visitor and s = savanna/woodland species; feeding guilds

DISCUSSION

Species diversity, abundance and distribution

The three study zones exhibited different levels of bird richness as well as groups of birds. Some birds (e.g. African darter, *Anhinga rufa* and Common squaco heron, *Ardeola ralloides*) were not common in the more human disturbed habitats such as core-urban and sub-urban zones indicating the influence of urbanization on local birds diversity (McKinney, 2008). It was observed varying levels of disturbance where rural zone (Mzinga and surrounding areas) had a relatively lower level of disturbance characterized by farming activities than sub-urban zone (Falkland and adjacent areas) with a moderate habitat disturbance. On the other hand, Morogoro core urban zone was highly impacted by human settlements, local home-gardens with more non-native plant species (Rija *et al.* 2014). Results of this study are consistent with the general observations that low level of disturbance can act to increase species richness relative to the area with high level of disturbance (McKinney 2008). In this study, the core-urban zone had the lowest species richness compared to other two study sites (rural and sub-urban zones), perhaps because of the extensive removal of native tree species and expansion of human settlements (Rija *et al.* 2014) that had resulted in decreased nesting and feeding sites for the native avifauna. Comparatively, the results of this study showed that the rural area had highest bird species diversity while the core urban area had lowest bird species diversity consistent with previous studies done in other areas (Marzluff 2001, Chace and Walsh 2006).

Species diversity was higher in the rural zone than in the sub-urban and core-urban zones presumably due to their differences in habitats and a variety of natural food resources for the birds. The rural zone had more natural vegetation than the other two zones certainly not counterparts (Rija *et al.* 2014) that may have supported the birds with food resources such as fruits and insects. Vegetation complexity in terms of vertical heterogeneity and tree density has been reported as a major factor determining bird diversity and abundance (Gove *et al.* 2008, Mulwa *et al.* 2012). The non significant difference in species diversity found between the rural zone and sub-urban zone may be explained by being contiguous to each other. These zones have relatively similar vegetation composition (Rija *et al.* 2014) which are likely to support relatively similar resources required for bird survival. Mulwa *et al.* (2012) observed that differences in feeding habits and habitats could increase species richness, evenness and diversity, thus supporting the results of the current study.

Bird abundance increased from rural zone to the core-urban consistent with reports of other studies (Tratalos *et al.* 2007, Catteral 2009, Gagne and Fahrig 2011). The results also support the observations that core-urban habitats are associated with high bird abundances for some species (Savard *et al.* 2000). In Morogoro core-urban zone, the common bulbul (*Pycnonotus barbatus*) was most common and widely distributed species. Its distribution may have been influenced by food availability such as fruits because of the associated gardening activities in the area (Said 2012, Rija 2003). Furthermore, the two species of sparrow, House Sparrow (*Passer domesticus*) and Grey-headed Sparrow (*Passer griseus*), the former being an introduced species to East Africa (Wium-Andersen and Reid 2000) were the most abundant species distributed in the core-urban perhaps because they are fond of disturbance associated with human settlements in the study area (Rija 2003). Increase in bird abundance from rural zone to core urban zone might be as a result of increase in food abundance, refuse and exotic vegetation in core-urban zone (Rija *et al.* 2014, Rija 2003, Marzluff 2001). Moreover, the results showed that bird species in the study were more or less evenly distributed across the core-urban and sub-urban zones. This may be due to a potentially homogeneous vegetation community across the two named zones (Rija *et al.* 2014) that potentially support similar food resource base across the study area.

Bird Habitats and Feeding Guilds

The study zones showed variation in both habitats and feeding guilds. Bird guild composition is important as it is used to assess environmental conditions and has widely been used as indicator of the quality of the environment (Kotwal *et al.* 2008). The presence of specialist and generalist bird species in the study zones suggests the importance of the study area for species conservation. East Africa has a rich pool of species of birds that are adapted to open landscapes such as the savannah, which colonize the former forest areas after conversion and disturbance. This makes the region important refugia even for threatened species (Mulwa *et al.* 2012). The presence of forest bird species in rural and sub-urban zones of our study area was attributed to the presence of surrounding mountain forest and forest patch remnants around the Uluguru Mountains which are part of the Eastern Arc biodiversity hotspot. However, continued reduction in patch sizes associated with the urban sprawl could potentially diminish the ecological requirements for forest-dependent birds, and create habitats for generalists (Owino *et al.* 2008). Results of this study are

consistent with observations by Owino and colleagues because it was observed that majority of the birds were generalists suggesting clearly the effects of land use change on bird community composition in the study area. Additionally, Morogoro core-urban is composed of less heterogeneous vegetation than the rural zone (Rija *et al.* 2014) which essentially may result into more insectivore birds occupying more of the rural zone than the urban disturbed habitats (Mulwa *et al.* 2012). Furthermore, the results are consistent with Gray *et al.* (2007) who concluded that, increase in urbanization can result in a decline of insectivorous species and increase in abundance of granivores. In the current study, seed eaters were more abundant in core-urban zone characterized by more open patches as these areas tend to support more granivorous birds (Shochat *et al.* 2010). This study also found that natural and semi-natural habitats tend to be associated with higher avian guilds composition, indicating that avian guilds composition depends largely upon the degree to which natural habitats have been altered (Savard *et al.* 2000). These results further suggest that changes in habitat suitability due to anthropogenic alteration (e.g. urbanization processes) are likely to influence species feeding guild composition as do events that change food availability (Holmes and Sherry 2001).

CONCLUSION

Bird species richness and diversity decreased toward the core urban area suggesting the likely impact of urbanization pressures on bird composition in the study area. Urban planners should incorporate conservation strategies into the city development agendas to reduce negative effects of urban sprawl on local biodiversity. The results also show that the area still harbours rich avifauna including migratory birds, forest species and endangered species highlighting the area's importance for avifauna conservation. There is therefore a great potential for the area to be promoted into a well conserved area that could attract more bird species for potential promotion of local community development through avitourism. Elsewhere avitourism is a growing business increasingly recognized as job creator and a promoter of biodiversity conservation (Biggs *et al.* 2011). This study should serve as a basis for future bird monitoring work and for eventual adoption of integrated conservation approaches to enhance nature conservation in the greater Morogoro urban ecosystem.

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