Journal of East African Natural History **98**(2): 167–209 (2009)

THE FORGOTTEN 'COASTAL FORESTS' OF MTWARA, TANZANIA: A BIOLOGICALLY IMPOVERISHED AND YET IMPORTANT ECOSYSTEM

Giulia Wegner
Wildlife Conservation Research Unit, Department of Zoology, University of Oxford
Tubney House, Abingdon Road, Tubney, Abingdon OX13 5QL, UK
giulia_wegner@yahoo.com

Kim M. Howell
Department of Zoology and Wildlife Conservation, University of Dar es Salaam
P.O. Box 35064, Dar es Salaam, Tanzania
kmhowell@udsm.ac.tz

Tim R.B. Davenport
Wildlife Conservation Society
P.O. Box 1475, Mbeya, Tanzania
tdavenport@wcs.org

Neil D. Burgess
Conservation Science Group, Zoology Department, University of Cambridge
Downing Street, Cambridge CB2 3EJ, UK
&
WWF US Conservation Science Programme
1250 24th Street NW, Washington DC, USA
neil.burgess@wwfus.org

ABSTRACT

Biodiversity surveys and the compilation of indigenous knowledge were conducted in eight previously unstudied proposed and already gazetted Forest Reserves of Mtwara Region, south-eastern Tanzania, from April to August of 2005. The results indicate relatively low biodiversity and endemism values in these forests, and high levels of forest disturbance. In most areas the original vegetation has been converted by clearance for cultivation and by fire, and has regenerated into degraded forms of Swahilian/Coastal Mixed Dry Forest, Swahilian/Coastal *Brachystegia* Forest and floristically impoverished Zambezian-Swahilian *Brachystegia* Woodland. Some Coastal Forest endemic and threatened species, however, occur in the degraded forest patches, such as east coast akalat *Sheppardia gunningi,* Reichenow's batis *Batis mixta reichenowi*, spotted flat-lizard *Platysaurus maculatus,* woodland toad *Mertensophryne micranotis* and the shrub *Gardenia transvenulosa*. The low proportion of endemic and threatened species recorded implies that these forests are of modest biological importance within the context of the Eastern Arc Mountains and Coastal Forests Biodiversity Hotspot. Nevertheless, local inhabitants depend heavily on the long-term

availability of timber and non-timber resources and water and soil regulation services from these forests. The development and implementation of effective natural resource management is therefore urgently needed in this area.

Keywords: coastal forest mosaic, biodiversity hotspot, biodiversity survey, forest disturbance, species checklist, East Africa

INTRODUCTION

Mtwara Region, at the border with Mozambique in south-eastern Tanzania, is renowned as an export channel for cashews and sisal, and for being home to the Makonde wood carvers. It is less well known for being part of the Eastern African Coastal Forests Biodiversity Hotspot (Mittermeier *et al.*, 2004). The high biodiversity and concentration of endemic, rare and threatened species make the Coastal Forests, together with the adjoining Eastern Arc Mountain forests, one of the highest priority for conservation in Africa and globally (Burgess & Clarke, 2000a; Myers *et al.*, 2000; Brooks *et al.*, 2002; CEPF 2005).

Little was known about the biology of the Coastal Forests in Mtwara Region prior to the present study. Field surveys were therefore conducted from April–August 2005 by Frontier-Tanzania in eight proposed and gazetted Forest Reserves in Mtwara Region that partially comprise Key Biodiversity Areas 81, 95 and 102 (CEPF, 2005). The objectives of this paper are to: 1) assess the Reserves' biological value in terms of presence of endemic and threatened species; 2) identify geographical and habitat range extensions; 3) evaluate the current incidence of human disturbance; and 5) make broad conservation suggestions.

In this paper we adopt a definition of the Coastal Forests Mosaic as broadly corresponding to the "Swahilian region *sensu lato*" (White, 1983; Clarke, 1998). This phytochorion forms an archipelago of lowland forests extending up to 300 km inland between the equator in southern Somalia and the estuary of the Limpopo River in southern Mozambique. The Coastal Forests Mosaic comprises various closed-canopy forest types within a matrix of savanna-woodland and synanthropic vegetation (Clarke, 2000b). Closed-canopy Coastal Forest habitat covers just 3172 km^2 of the area (*ca.* 1% of the Swahilian region *sensu lato*), and is characterised by the highest concentration of biodiversity and endemism in the area (Burgess & Clarke, 2000a; CEPF, 2005).

The biota of the Coastal Forests is characterised by locally disjunct distribution patterns and a high degree of regional and point endemism (CEPF, 2005). These distribution patterns are probably the result of both natural habitat heterogeneity due to climate changes and historical fragmentation due to human use (Azeria *et al.*, 2007). The gradual desiccation of the African continent that started in the Miocene may have fragmented a formerly more contiguous forest cover along the Tanzania coast (Clarke, 2000a). More recently, habitat fragmentation was accelerated by anthropogenic fire and cultivation patterns (Clarke & Karoma, 2000).

DESCRIPTION OF THE STUDY AREA

The Administrative Region of Mtwara is located in south-eastern Tanzania, and is bordered to the north by the Lindi Region, to the east by the Indian Ocean, to the south by Mozambique and the Ruvuma River, and to the west by the Ruvuma Region. The study sites are located within 038°10'–039°60'E and 10°35'–11°10'S (figure 1). They have an elevation range between 120 and 720 m and cover a total area of 178 km^2 (table 1), with the plateau of

the Makonde Escarpment lying between 700 and 900 m (Dar es Salaam Planning Commission & Mtwara Regional Commissioner's Office, 1997).

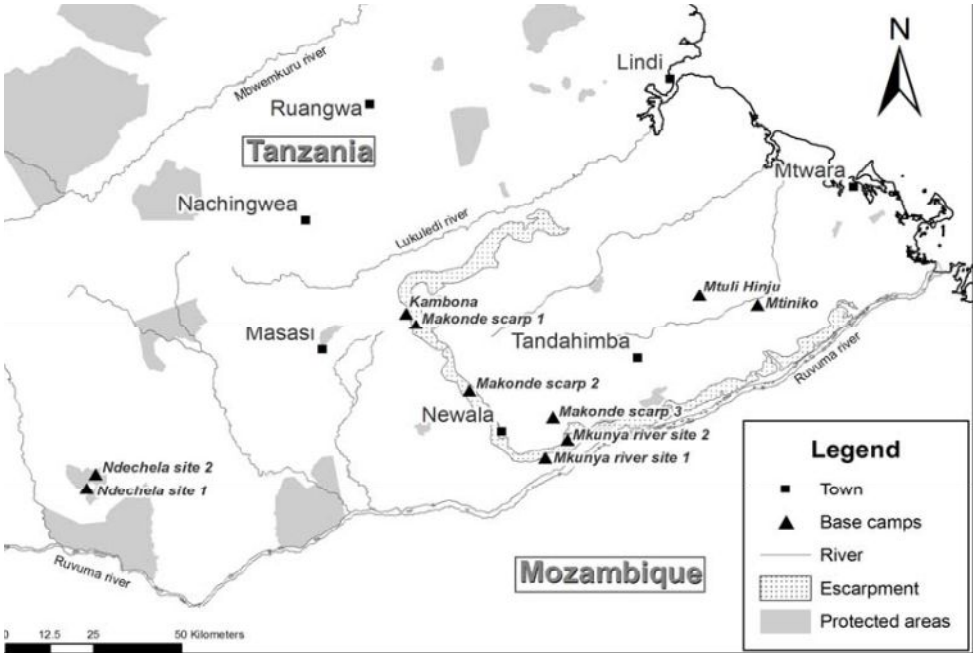


Figure 1. Map of the study region showing the research base camps within the studied forest areas, the major towns, rivers and the edge of the Makonde Escarpment.

The region has two geological zones. The first is the Coastal Sedimentary Formation extending 125 km from the Indian Ocean to the edge of the Makonde Plateau, which produces deep, well drained sandy soils of low fertility and low moisture holding capacity. The second zone consists of pre-Cambrian gneisses and granulites extending west of the coastal sediments, which gives rise to deep, well drained red clays to the north of Masasi town, coarse grained sandy soils to the south of Masasi town, and well drained, nutrient poor and heavily leached soils on the Makonde Escarpment (Dar es Salaam Planning Commission & Mtwara Regional Commissioner's Office, 1997). The cause of soil erosion on the Makonde Escarpment may be both anthropogenic (clearance and shifting cultivation) and natural (the rapid erosion of the sandstone plateaux and hills) (Clarke, 2000b).

From November/December to April/May winds from the north-east bring a hot and humid rainy season. The rest of the year the region is kept drier and cooler by the south-easterly winds. Annual precipitation varies with altitude: 1160 to 935 mm on the hills and plateau, 1001 mm at Newala, and 893 mm at Masasi. Temperatures in coastal Mtwara vary from 27°C as the highest monthly mean temperature in December to 23°C as the lowest monthly mean temperature in July. Relative humidity ranges from ca. 87% as the highest monthly mean humidity in March to ca. 79% as the lowest monthly mean humidity in October. Temperatures and humidity are lower inland (Dar es Salaam Planning Commission & Mtwara Regional Commissioner's Office, 1997).

Table 1 General features of the study sites in eight forests in Mtwara region, south-eastern Tanzania.

Forest Reserve (FR)	District	Protection status	Latitude (S) & longitude (E)	Nearby towns & villages	Water body	Altitude (m asl)	Size (km^2)
Kambona	Masasi	Gazetted	10° 37' 09.4" 039° 01' 14.8"	Chiwata, Chidya	Chidya Spring	670–700	0.3
Makonde Scarp I	Masasi	Proposed	10° 38' 56.3" 039° 02' 45.3"	Chidya, Mjembe		600–640	17.48
Makonde Scarp II site 1	Newala	Proposed	10° 50' 25.3" 039° 10' 46.2"	Newala, Lulindi		550–780	15.54
Makonde Scarp II site 2			10° 50' 19.9" 039° 10' 51.0"				
Makonde Scarp III	Tandahimba	Proposed	10° 53' 34.6" 039° 24' 24.2"	Lidumbe, Mcholi		340–435	14.35
Mkunya River Site 1	Newala	Proposed	10° 50' 27.5" 039° 23' 54.1"	Mkunya, Chiunjila, Chikwedu, Mapili,	Mkunya Spring	88–250	47.97
Mkunya River Site 2			10° 58' 44.4" 039° 26' 58.4"	Nanguruwe, Magunchila			
Mtiniko	Mtwara Rural	Proposed	10° 35' 26.7" 039° 56' 06.6"	Mtimiko, Newata		170–210	17.36
Mtuli Hinju	Mtwara Rural	Proposed	10° 35' 27.6" 039° 47' 11.2"	Mtuli-mjemgua, Hinju	Mtuli Hinju Spring	215–260	2.96
Ndechela Site 1	Masasi	Gazetted	11° 06' 16.8" 038° 09' 43.1"	Ndechela, Nakopi Nihale	Lukwimba River (at border)	250–340	62.16
Ndechela Site 2			11° 04' 27.0" 038° 12' 32.0"				

The studied sites were proposed between 1955 and 1977 as protected Forest Reserves (FRs) by the central government in recognition of their importance to the local villages and towns as water catchments, for prevention of soil erosion, and for provision of timber and non-timber forest resources (information made available by the Masasi District Natural Resources Office, 2005). The water sources of the Mkunya River and Makonde Plateau FRs provide a water supply to the towns of Newala and Mahuta. The small spring in Kambona FR is the sole water supply for the villages of Chidya and Chiwata. The pond in Mtuli Hinju FR supplies alone the villages of Mtuli Hinju and Njengwa, and another six villages (Chiwindi, Majengo, Migombani, Mtalala, Nang'awanga and Najenga) rely on it seasonally when alternative ponds and wells dry up. The threat of soil erosion, on the other hand, is particularly evident on and at the foot of the Makonde Escarpment, because here soils are particularly vulnerable to erosion by heavy seasonal rains. At present, two of the sites are gazetted Forest Reserves and six are proposed Forest Reserves (table 1). From this point on we shall refer to all eight sites as Forest Reserves regardless of their actual gazettment status.

MATERIALS AND METHODS

For a detailed description of data collection methods refer to the online *Technical Report No. 29* (Stubblefield & Cunneyworth, 1997). In brief, data on fauna were collected at zoological trap sites (abbreviated as zoosites). Zoosites were chosen to cover the largest range of habitats possible (*e.g.* riverine forest, open woodland, grassland), and one zoosite was placed randomly within each habitat. The size of the zoosite was determined by the length of the bucket pitfall line (20 m) and the area used to place Sherman traps around this line.

Sherman and bucket pitfall traps were used to record reptiles, amphibians, and small rodents and insectivores (diurnal, crepuscular, and nocturnal) whose habitat is the forest floor or those that are adapted to climbing (scansorial). Amphibian sounds were also recorded through a dictaphone. Bat and bird mist netting was used to record bat species (nocturnal and crepuscular) and understorey and lower canopy bird species. Birds were also recorded through timed searches. Canopy trapping sampled fruit-feeding butterflies, while timed sweep netting was used to sample butterflies in the forest understorey, scrub, thicket, herbs
and grasses. Small mammals and birds that were to be released were marked by trimming a small patch of fur/feather in order to avoid duplicity of results. Reptiles and amphibians were not marked.

One kilometre mammal track and sign transects were carried out to record data on large mammal species. Dung was recorded within a 4 m wide strip (2 m either side of the transect). Presence of all other signs (footprints, burrows, scratchings, nests and ground resting sites) were recorded within a 10 m wide strip (5 m either side of the transect). See table 2 for a break down of the survey effort.

Specimens for all taxa, with the exception of large mammals, were retained when identification in the field was not possible. Specimens were sent for identification and repository to the Department of Zoology and Wildlife Conservation, University of Dar es Salaam, Tanzania; butterflies were sent to the Southern Highlands Conservation Programme (SHCP), Wildlife Conservation Society, Tanzania. Specimens were also sent on loan for further verification to: the Natural History Museum, London, UK; the California Academy of Sciences, San Francisco, USA; the Field Museum, Chicago, USA; the Natural History Museum of Zimbabwe, Bulawayo, Zimbabwe; the Zoological Museum, Copenhagen, Denmark. Data from this study contribute to the Biodiversity Database of the University of Dar es Salaam, Tanzania, the TROPICOS database of Missouri Botanical Garden, USA, and the CEPF Conservation Outcomes Database, USA.

Table 2 Summary of survey effort deployed to record data on the fauna in eight forests in Mtwara region, south-eastern Tanzania.

		Sampling intensity								
		Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	MakondeIII	Ndechela	TOTAL
Reserve size (km^2)		0.3	17.48	15.54	47.97	17.36	2.96	14.35	62.16	178.12
Days		5	7	7	14	7	5	7	14	66
Sampling intensity (% of each FR)		0.5	0.02	0.03	0.02	0.03	0.07	0.03	0.01	
Data for:	Survey technique (and sampling unit): fauna									
Small mammals	Sherman traps 40 traps x no. trapping nights	120	200	200	400	200	120	200	400	1840
Rodents, reptiles, amphibians	Bucket pitfall traps 10 buckets x no. trapping nights	30	50	50	100	50	30	50	100	460
Bats	Bat netting (net-hours) *	20.2	2.7	6.0	39.0	31.5	15.0	-	86.0	200.45
Birds	Bird netting (man-hours) *	-*	20.5	-*	38.5	37.5	24.5	-*	13.0	134
Birds	Timed bird searches (man-hours)	15.0	6.0	8.0	16.0	14.0	7.0	18.0	16.0	100
Canopy dwelling butterflies	Canopy traps 3 traps x no. trapping days	9	15	15	30	15	9	15	30	138
Lower storey dwelling butterflies	Butterfly sweep netting (sweep-net hours)	2.0	4.5	6.0	10.5	6.0	2.0	4.5	4.0	37.5
Reptiles, Amphibians	Timed herpetofauna searches (man-hours)	4.0	4.5	4.5	17.5	6.0	4.0	4.5	7.0	52.5
Larger mammals	Animal sign transects (m²) 1000 x 2 m either side**	1 x 500 m 1 x 600 m 4400 m²	(3) 12000 m²	(4) 16000 m²	(7) 28000 m²	(4) 16000 m²	1 x 1000 m 1 x 900 m 7600 m²	(3) 12000 m²	(7) 28000 m²	(31) 124000 m²
Data for:	Survey technique (and sampling unit): human use									
Human disturbance	Transects (m²) 1000 x 5 m either side**	(1.1) 11000 m²	(3) 30000 m²	(4) 40000 m²	(7) 70000 m²	(4) 40000 m²	(1.9) 19000 m²	(3) 30000 m²	(7) 70000 m²	(31) 310000 m²

*Varying sizes of bird and bat mist-nets were used each time.
** The number of transect sections is indicated in brackets, the total m² are indicated on the following line.

Endemism, conservation status, forest dependence and range extensions

Species were classified as: *forest dependent* or *specialist* (F), *i.e.* species restricted to primary or closed-canopy forest only and likely to disappear if the forest is modified to any great extent; *forest dwelling* or *generalist* (f), *i.e.* species that may occur in undisturbed primary or closed-canopy forest, but are able to exist in clearings, fragmented and secondary forest, woodland and at the forest edge that depend upon the forest for some of their resources, so thus may be adversely affected by forest destruction; *non-forest* or *forest visitor* (O), *i.e.* species that may occur in primary or secondary forest or at the forest edge, but are usually recorded in open habitats and thus are not dependent upon the forest.

Endemic species were categorised as: *endemic* (E), species with ranges limited to the Coastal Forests; *near endemic* (NE, species with ranges limited to the Coastal Forests and Eastern Arc Mountains, sometimes including other habitats in adjacent locations (*e.g.* Masasi District, northern Mozambique).

Animals were classified as threatened if listed in the IUCN Red List (2009) as *critically endangered* (CR), *endangered* (EN) or *vulnerable* (VU), and if listed on CITES Appendix I (2009) as *threatened with extinction and therefore excluded from international trade*.

Animal species found to occur outside their previously documented habitat and/or geographical range were reported as *range extensions*. To assess known ranges we used: Kingdon (1974, 1984, 2003) and Burgess *et al.* (2000a) for mammals; Zimmerman *et al.* (1996), Mlingwa *et al.* (2000), Stevenson & Fanshawe (2002) and Sinclair & Ryan (2003) for birds; Howell (1993), Broadley & Howell (2000) and Spawls *et al.* (2002) for reptiles; Passmore & Carruthers (1995), Schiøtz (1999), Poynton (2000) and Channing (2001) for amphibians; Kielland (1990), Larsen (1996), Kielland & Cordeiro (2000) and Davenport (2001) for butterflies.

Human resource-use and forest disturbance

One kilometre transects were used to record the incidence of disturbance caused by various human activities, *i.e.* clearance for cultivation, pole/timber extraction, pit sawing sites, bark ringing, burning, hunting and paths (see Frontier-Tanzania, 1997). Transects were placed randomly at 1 km intervals within each Forest Reserve, and the number of transects used varied according to the size of the Reserve. The *relative level of disturbance* (RLD) was analysed by calculating the percentage of 50 m transect sections containing various forms of disturbance. The *relative abundance* (RA) of live, naturally dead and cut poles/timbers/large timbers takes into account the number of individuals of one category relative to the total number of individuals from all categories recorded in an area.

Structured interviews and open discussions were held with local government officers from the Mtwara, Masasi, Tandahimba and Newala District Natural Resources Offices, and a minimum of three village elders from each village within the vicinity of the Forest Reserves. The aim was to collate information about natural resource use and local management perceptions.

RESULTS

In total, 355 faunal species belonging to 104 families were recorded by this study: 39 large mammals, 22 small mammals, 158 birds, 31 reptiles, 24 amphibians and 81 butterflies (appendices 1 to 5).

Endemic species

A total of three species are endemic or near endemic to the Coastal Forest and/or the Eastern Arc Mountains: one bird, Reichenow's batis *Batis mixta reichenowi* (E); one reptile, spotted flat-lizard *Platysaurus maculatus* (NE); and one amphibian, woodland toad *Mertensophryne micranotis* (NE) (appendices 2–4). These species constitute 1–2% of the species recorded in each Forest Reserve, no Reserve containing more than two endemic species. Overall, these three species comprise < 2% of the total number of species recorded.

Species near endemic to the Coastal Forests and Eastern Arc Mountains as well as some other habitats in East Africa include small-eared greater galago *Otolemur garnettii,* lesser pouched rat *Beamys hindei*, and east coast akalat *Sheppardia gunningi* (appendices 1 and 2).

Threatened species

Four faunal species were found to be globally threatened, which together constitute < 2% of all fauna recorded by this study. These include two large mammals, common hippopotamus *Hippopotamus amphibius* (VU) and lion *Panthera leo* (VU). Two species, leopard *Panthera pardus* and peregrine falcon *Falco peregrinus* are listed on CITES Appendix I (2009) (appendices 1, 2 and 4).

Mammal and bird species with a lower degree of threat on the IUCN Red List (2009) were also recorded. These include three *near threatened* (NT) mammal species, chequered elephant shrew *Rhynchocyon cirnei,* bush elephant *Loxodonta africana* and leopard; three NT birds, east coast akalat *Sheppardia gunningi*, southern banded snake eagle *Circaetus fasciolatus* and Lilian's lovebird *Agapornis lilianae* (appendices 1 and 2).

The globally threatened plant species *Gardenia transvenulosa* (VU) was also recorded (IUCN, 2009).

Forest dependent species

Forest dependent species were mainly recorded in dense understory of *Brachystegia* Woodland, Mixed Dry Forest and Riverine Forest, and constitute only a small proportion of the faunal community recorded. None of the small mammals recorded are forest dependent, five of the large mammals are forest dependent, and one bat species is forest dwelling but not forest dependent. A total of seven bird species are forest dependent. Two reptiles and four amphibians favour forest habitats. Of the butterfly species surveyed, seven are forest dependent (appendices 1–5).

Range extensions and new records

No significant range extensions were recorded. Since no previous surveys were conducted in the eight Forest Reserves, some of the widespread and common bird and butterfly species found are likely to constitute first records in these studied sites (Kielland, 1990; Larsen, 1996; Davenport, 2001; Jacob Kiure, pers. comm.) (appendices 2 and 5).

Human resource-use and forest disturbance

Table 3 displays and compares the percentage of 50 m transect sections that were subject to disturbance and the incidence of different forms of impact. In four Forest Reserves, > 90% of sections showed some sign of disturbance (Makonde Scarp III - 100%, Makonde Scarp II - 96%, Mkunya River and Kambona - 95%), and no Forest Reserve had < 8% of sections bisected by paths.

The Forest Reserves most affected by agricultural encroachment were Makonde Scarp I (29%), II (42%) and III (43%). Although our transects indicated a low level of encroachment in Mkunya River FR (2% of sections), in fact the valleys cutting through the escarpment

Table 3 Percentage of total and specific types of human disturbance (recorded as occurring in 50m sections along transect lines) and number and percentage relative abundance (%RA) of live, dead and cut poles/timbers/large timbers along the transect lines, in eight forests in Mtwara region, south-eastern Tanzania.

Forest Reserve	Total transect length (m)	% total disturbance	% cultivation	% fire	%paths	% bark ringing	% traps	% cutting	No. of individuals sampled	No. (and % RA) of dead individuals	No. (and % RA) of cut individuals
Kambona	1100	95	0	9	27	9	0	95			
								Pole	735	15 (2)	217 (30)
								Timbers	277	8 (3)	20 (7)
								Large timbers	39	2 (5)	0 (0)
Makonde I	3000	87	29	70	8	2	0	78			
								Pole	2182	36 (2)	458 (21)
								Timbers	447	14 (3)	36 (8)
								Large timbers	11	0 (0)	1 (9)
Makonde II	3950	96	41	73	19	3	1	87			
								Pole	2669	52 (2)	727 (27)
								Timbers	310	27 (9)	58 (19)
								Large timbers	0	0 (0)	0 (0)
Mkunya Riv.	7000	95	2	41	8	0	0	94			
								Pole	4774	164 (3)	970 (20)
								Timbers	1027	83 (8)	25 (2)
								Large timbers	20	0 (0)	0 (0)
Mtiniko	4000	60	0	8	15	0	5	39			
								Pole	5015	561 (11)	92 (2)
								Timbers	534	40 (8)	4 (1)
								Large timbers	6	1 (17)	0 (0)
Mtuli Hinju	1900	57	5	15	8	0	3	43			
								Pole	1176	98 (8)	71 (6)
								Timbers	292	43 (15)	11 (4)
								Large timbers	6	0 (0)	0 (0)
Makonde III	3000	100	43	30	22	0	0	87			
								Pole	1245	104 (8)	462 (37)
								Timbers	396	77 (19)	58 (15)
								Large timbers	7	0 (0)	1 (14)
Ndechela	7000	74	0	72	9	0	1	18			
								Pole	309	394 (13)	16 (1)
								Timbers	1129	95 (8)	10 (1)
								Large timbers	33	2 (6)	0 (0)

were largely transformed into cashew nut plantations. In Kambona, Mtiniko and Ndechela FRs, encroachment is negligible or absent, but it occurs right up to the Forest Reserve boundaries.

All Forest Reserves were affected by pole and timber cutting, Kambona and Mkunya River being those most severely affected (> 90% of sections). Five of the eight Forest Reserves contained at least one recently active or old pit-sawing site.

Fuelwood was reported by village elders to be obtained from dead trees and branches in all Forest Reserves. Results from this study add to the existing list of species used for the construction of tool handles and cooking utensils (Burgess *et al.*, 2000b). The production of burnt bricks, which uses large volumes of wood to produce heat, was a common practice in Makonde Scarp II FR.

Extraction of medicinal plants and fruits from trees like the marula *Sclerocarya birrea* and *Strychnos* spp. occurs within all Forest Reserves on a small scale. The roots of *Dioscorea hirtiflora* are an important source of carbohydrate exploited for sale on local markets. Honey is produced and sold locally in Makonde Scarp II and Ndechela FRs.

Four of the eight forests contained ringed trees, but anecdotal evidence from interviews suggested that bark ringing also takes place in the other Forest Reserves. Discussions with local people revealed that bark ringing occurs in order to remove bark for use as ropes, beehives and medicine.

Hunting takes place in most of the sites. Mtiniko and Mtuli Hinju FRs had the highest density of traps recorded (in 5% and 3% of 50 m sections, respectively). In most cases the traps were either snares targeting ungulate species or smaller devices placed in the riverbed to catch birds; in addition a drift fence was found in Ndechela FR. All hunted species are said by residents to have declined over the last 10 years. Hunting in Kambona, Makonde Scarp I and Ndechela FRs involves threatened species such as chequered elephant shrew and small-eared greater galago (CITES Appendix II).

DISCUSSION

Biodiversity value

Endemic and threatened species constitute < 2% of all species recorded in the study area. This percentage is low, considering that rates of faunal endemism in the Coastal Forest Mosaic are *ca.* 7% for mammals, *ca.* 10% for birds, *ca.* 57% for reptiles and *ca.* 36% for amphibians (Burgess & Clarke, 2000a; CEPF, 2005).

Endemic species

In this paper we adopt the classification of Reichenow's batis as a subspecies of forest batis *Batis mixta* (Fjeldså *et al.*, 2006). Under this classification, *B. mixta reichenowi* is endemic to the Coastal Forests of south-eastern Tanzania. This bird was recorded in Mtiniko FR, an area classified as the Mtwara District Coastal Forests Important Bird Area (IBA TZ052). If Reichenow's batis was to be recognised as a separate species from *B. mixta* (Mlingwa *et al.*, 2000; Baker & Baker, 2002), then this IBA could be upgraded as part of a Secondary or Full Endemic Bird Area (Baker & Baker, 2002).

The spotted flat-lizard is endemic to northern Mozambique and the Masasi District in south-eastern Tanzania, where it only inhabits rock outcrops of granite, gneiss and sandstone that weather to produce thin fissures where it seeks refuge (Spawls *et al.*, 2002). During this study, spotted flat-lizards were abundant in Ndechela FR, where they find their habitat in the granite kopjes protruding from the plain up to 800 m.

The woodland toad, a species endemic to the Eastern Arc lowland and the Coastal Forests Mosaic of south-eastern Kenya and eastern Tanzania (Conservation International, 2005) was found in an area of regenerating *Brachystegia* woodland, confirming that it can also survive in modified secondary habitats (Broadley & Howell, 2000).

The studied sites are not characterised by the unique butterfly fauna found in other Coastal Forests of Tanzania (Kielland & Cordeiro, 2000).

Threatened species

The bush elephant (NT, CITES Appendix II) was only recorded in Ndechela FR from a footprint, and the common hippo was reported by local inhabitants to occur in the same Forest Reserve. The extent of their occurrence in the studied area needs further clarification. Leopards (CITES Appendix I) inhabit sheltered areas near the cliff face in Makonde Scarp II FR, and were reported by residents to occur in the adjacent Makonde Scarp I, Kambona and Mkunya River FRs. Leopards are not dependent upon forest habitat; nonetheless, they may need the Forest Reserves as corridors between suitable patches of habitat or for alternative sources of food and shelter (Kingdon, 2003).

Elephant shrews observed in this study range in colour from light grey with white marks to dark grey and rufous with indistinct chequers. These colour variations match those described for several subspecies of the chequered elephant shrew *R. cirnei* (Rathbun, 2005; 2006).

The east coast akalat has a restricted distribution in the Coastal Forests and few other forest types in eastern Africa (Jensen *et al.*, 2005). The relatively high number of individuals captured in Mtiniko FR (five during 37.5 hours of mist netting) points to this site as an important area for this bird.

Forest dependent species

Forest dependent large mammals were found in dense and relatively undisturbed pockets of forest and woodland amidst large areas of disturbed habitat, and include Sykes's monkeys *Cercopithecus mitis* subsp., the red-bellied coastal squirrel *Paraxerus palliatus*, blue duikers *Cephalophus monticola*, Natal duikers *Cephalophus natalensis* and sunis *Neotragus moschatus*.

Forest dependent bird species rely on a canopy-shaded and dense understorey (Mlingwa *et al.*, 2000). This explains why the African crowned eagle *Stephanoaetus coronatus*, African broadbill *Smithornis capensis*, yellow streaked greenbul *Phyllastrephus flavostriatus*, Fischer's greenbul *P. fischeri* and blue-mantled crested flycatcher *Trochocercus cyanomelas* were observed only among the dense lianas and shrubs of Mixed Dry Forest, and in small patches of dense *Brachystegia* Woodland and Riverine Forest.

Forest dependent species are vulnerable to reductions of closed-canopy forest habitat and to increases in the edge effect (Lehtinen *et al.*, 2003). They are therefore more prone to local extinction than generalist and edge-adapted species.

Human resource-use and forest disturbance

Conversion to agriculture is the most destructive activity in the Coastal Forests of eastern Africa, since it involves the complete removal of the natural habitat (Burgess *et al.*, 2000b). This problem is exacerbated by shifting cultivation, a traditional practice that has become unsustainable due to a human population growth rate that exceeds the regeneration capacity of the forest. In the study area, encroachment occurs more extensively where the forest boundaries are not clearly demarcated. The Forest Reserves most affected are those on the Makonde Escarpment. Here large areas of the slopes are covered by thicket, indicating that shifting cultivation is common even on slopes that are unsuitable for agriculture.

A recent study illustrated that districts in Mtwara Region accounted for a low proportion of those timber licences that were issued in 2001–2 (Milledge & Elibariki, 2005). Five of the eight Forest Reserves had, however, overall levels of pole cutting above the 16% upper threshold reported by previous studies of Coastal Forests (Burgess *et al.*, 2000b). In Mtiniko FR local people were observed to earn cash from timber cut inside the Forest Reserve, and these findings suggest that illegal timber extraction takes place in the studied Reserves. Moreover, the completion of the Mkapa Bridge across the Rufiji River in 2003 has contributed to escalating illegal timber harvesting and forest degradation in these southern regions (Milledge *et al.* 2007; Milledge & Kaale, 2005).

Previous evidence illustrated that pole and timber harvesting tends to be selective (Burgess & Mbwana, 2000; Milledge & Kaale, 2005). Findings from this study match those obtained by TRAFFIC in the regions south of the Rufiji River in 2001–2 (Milledge & Elibariki, 2005), with gum copal *Hymenaea verrucosa* Gaertn., African teak *Pterocarpus angolensis* DC., snake bean tree *Bobgunnia madagascariensis* (Desv.) J.H.Kirkbr. & Wiersema and pod mahogany *Afzelia quanzensis* Welw. being reported by local inhabitants as popular hard wood timber species, followed by *Millettia stuhlmannii* Taub., *Milicia excelsa* C.C.Berg and African blackwood *Dalbergia melanoxylon* Guill. & Perr.. Selective pole and timber harvesting is ecologically destructive as it alters the plant species composition of an area, which can in turn affect the faunal community that utilises that area (Robinson & Robinson, 1999; Vallan *et al.*, 2004). Furthermore, tree species differ greatly in their dispersal ability, and therefore the capacity of disparate species to recolonise an area after local extinction is not well known (Cordeiro *et al.* 2004; White *et al.*, 2004).

As in previous studies on fuel use (Burgess *et al.*, 2000b), most of the fuelwood was said by village elders to be obtained from dead trees and branches, including those from cashew nut plantations. Many of the species used for firewood at the study sites, however, overlap with those used for bark removal, indicating that trees die from the removal of bark and are then used for firewood.

Extensive and recurring burning in Ndechela FR is a particularly destructive form of disturbance. Fire destroys the soil top layer and the micro-fauna that lives within it, therefore reducing the availability of nutrients in the food-web. Fire also destroys the forest's understorey, which constitutes the main habitat for forest dwelling and forest dependent species (Bauder, 2000). As in other Coastal Forests (Burgess *et al.*, 2000b), some of these fires may be started deliberately to hunt animals.

Local management perceptions

During interviews with village elders and government officers, management by local inhabitants was reported to range from absent to ineffective among all Forest Reserves. The reasons appeared to be twofold: lack of incentives in terms of resource use and/or lack of financial and organisational support from local government offices.

The inhabitants of the Makonde Scarp, Mtiniko and Ndechela FRs do not view the gazettment of their forests positively because they see no benefits coming from such designation: no water source is present here that needs preservation from forest use, and no information has been forthcoming from the government about other reasons for the protection of these forests. This translates into a lack of management incentive, as the gazettment of the forests is perceived as a limit to the free use of resources with no benefits attached.

In areas where the designation of the Forest Reserves is viewed positively, for example Mkunya River and Kambona FRs because of their water supplies, communities have no legal entitlement to the management of the Reserves, and consequently lack the organisational and

financial support necessary to design and enforce community by-laws and to conduct patrols of the boundaries.

The insufficient enforcement of national forest legislation by local government offices constitutes another problem that hampers the management of the Forest Reserves in the study area.

Conservation recommendations

The forests in Mtwara region provide vital water supplies (especially Kambona, Mtuli Hinju, Mkunya River and Makonde Plateau FRs) and protection from floods and landslides (especially Makonde Plateau and Mkunya River FRs). This makes their conservation a regional priority.

Conservation in the Mtwara Coastal Forests should concentrate on both the effective enforcement of national forest law, and the involvement of local stakeholders in the management of resources through Joint Forest Management (JFM) between them and the government. If designed and implemented through inclusive forms of governance, JFM has the potential to empower and incentivise communities to pursue the conservation of forest resources and services (Blomley *et al.*, 2008), and to compensate for the low staffing and financial capacity of the Forestry and Beekeeping Division (Rodgers & Burgess, 2000). Conservation recommendations based on the findings of this study include: gazettement of all Forest Reserves, boundary reassessment and demarcation, capacity building among local forest officers, establishment of JFM between forest officers and local communities, establishment of local tree nurseries, and investment in rural services, infrastructures and affordable alternative sources of energy.

Finally, the Mtwara Coastal Forests are part of a mosaic system and rely on the stability of the whole system for the continuity of their floral and faunal communities. Consequently, adequate conservation measures need to be taken in as many parts of the mosaic as possible, and efforts should be made to restore and increase connectivity among fragmented forest patches. For example, it would be beneficial to combine Ndechela FR and the contiguous Lukwika-Lumesule Game Reserve into a single protected area, and for the whole of the Makonde Escarpment to be protected as one large Forest Reserve.

ACKNOWLEDGMENTS

We are particularly grateful to Dr. Don G. Broadley (Zimbabwe Natural History Museum, Zimbabwe), Dr. Bill Stanley (Chicago Field Museum, USA), Mr. Michele Menegon (Museo Tridentino di Scienze Naturali, Italy), Dr. Galen Rathbun (IUCN/SSC Afrotheria Specialist Group, California Academy of Sciences, USA), and Mr. Roger Gereau (Missouri Botanical Garden, USA), who offered invaluable support with the identification of collected specimens, and to Mr. Jonathan Green (University of Cambridge, UK) and Ms. Michela di Pace (independent consultant, Italy) for compiling the maps. We are also grateful to Frontier-Tanzania (a collaboration between the Society for Environmental Exploration and the University of Dar es Salaam) for implementing this survey project. Special recognition goes to the Frontier-Tanzania field team that collected field data, and specifically to Ms. Rosalind Salter (field research coordinator), Mr. Oisín Sweeney and Mr. Michael Cutts (research officers), Mr. Jacob Kiure (ornithologist), Mr. George Sangu (botanist), Mr. Ramathan Rajabu, Mr. Hassani Abedi and Mr. Mohammed Ali (field assistants). We also thank Mr. Paul Rubio (ex SEE Programme Manager) for managing this research project from the UK, Ms. Freya St. John (ex SEE country coordinator) for fundraising toward this initiative, and

Mr Dan Weaver (SEE Research & Development Co-ordinator) for providing useful editorial comments. Finally, we thank the Critical Ecosystem Partnership Fund (CEPF) for financing this project as a part of its research programme in the area (see www.cepf.net).

REFERENCES

Azeria, E.T., I. Sanmartín, Å. Stefan, A. Carlson & N. Burgess (2007). Biogeographic patterns of the East African coastal forest vertebrate fauna. *Biodiversity and Conservation* **16**: 883–912.

Baker, N.E. & E.M. Baker (2002). *Important Bird Areas in Tanzania: A First Inventory*. Wildlife Conservation Society of Tanzania, Dar es Salaam.

Bauder, J. (2000). *Effect of Fire on Soil and Vegetation*. MSU Extension Soil and Water Quality. Montana State University Communication Services, USA.

Blomley, T., K. Pfliegner, J. Isango, E. Zahabu, A. Ahrends & N. Burgess (2008). Seeing the wood for the trees: an assessment of the impact of participatory forest management on forest condition in Tanzania. *Oryx* **42**: 380–391.

Broadley, D.G. & K.M. Howell (2000). Reptiles. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 191–201.

Brooks, T.M., R.A. Mittermeier, C.G. Mittermeier, G.A.B. de Fonseca, A.B. Rylands, W.R. Konstant, P. Flick, J. Pilgrim, S. Oldfield, G. Magin & C. Hilton-Taylor (2002). Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology* **16**: 909–923.

Burgess, N.D. & G.P. Clarke (2000). *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp.1–443.

Burgess, N.D., D. Kock, A. Cockle, C. FitzGibbon, P. Jenkins & P. Honess (2000a). Mammals. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 173–191.

Burgess, N.D., P. Matthews, Y. Evers & K. Woodcock (2000b). Non timber uses, threats and local attitudes. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 281–303.

Burgess, N.D. & S.B. Mbwana (2000). Forestry. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 263–281.

CEPF (2005). Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya. Ecosystem Profile. Critical Ecosystem Partnership Fund, Arlington, USA www.cepf.net/ImageCache/cepf/content/pdfs/cepf_2eeasternarcmountains_2eoverview_5f3_2e05_2epdf/v2/cepf.easternarcmountains.overview_5f3.05.pdf [accessed November 2005].

Channing, A. (2001). *Amphibians of Central and Southern Africa*. Cornell University Press, USA.

CITES (2009). Convention on International Trade in Endangered Species of Wild Flora and Fauna. Appendices I and II. http://www.cites.org/eng/resources/species.html [accessed September 2009].

Clarke, G.P. (1998). A new regional centre of endemism in Africa. In C.R. Huxley, J.M. Lock & D.F. Cutler (eds.), *Chorology, Taxonomy and Ecology of the Floras of Africa and Madagascar*. Royal Botanic Gardens, Kew. Pp. 53–65.

Clarke, G.P. (2000a). Climate and climatic history. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 47–68.

Clarke, G.P. (2000b). Defining the eastern African coastal forests. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 9–26.

Clarke, G.P. & Karoma, N.J (2000). History of anthropic disturbance. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 251–262.

Cockle, A., D. Kock, L.K. Stubblefield, K.M. Howell & N.D. Burgess (1998). Bat assemblages in Tanzanian Coastal Forests. *Mammalia* **62**: 53–68.

Conservation International (2005). Biodiversity Hotspots Website: Coastal Forests of East Africa. Conservation International, Arlington, USA. http://www.biodiversityhotspots.org /xp/Hotspots/coastal_forests/ biodiversity.xml [accessed December 2005].

Cordeiro, N.J., D.A.G. Patrick, B. Minis & V. Gupta (2004). Role of dispersal in the invasion of an exotic tree in an east African subroutine forest. *Journal of Tropical Ecology* **20**: 449–457.

Dar es Salaam Planning Commission & Mtwara Regional Commissioner's Office. (1997). Mtwara Region Socio-economic Profile. Dar es Salaam Planning Commission, Tanzania. Pp. 223.

Davenport, T.R.B. (1996, revised 2001). *An Annotated Catalogue of the Butterflies of Uganda*. The Forest Department & Makerere University, Kampala.

Fjeldså J., R.C.K. Bowie & J. Kiure (2006). The forest batis, *Batis mixta*, is two species: description of a new, narrowly distributed *Batis* species in the Eastern Arc Biodiversity Hotspot. *Journal of Ornithology* **147**: 578–590.

Stubblefield L. & P. Cunneyworth (eds.) (1997), Technical Report No. 29. Methodology Report for the East Usambara Biodiversity Surveys. Society for Environmental Exploration, London. Pp. 141. www.frontier.ac.uk/gap_year/Tanzania_Forest_Savanna_Reports/#FM

Howell, K.M. (1993). Herpetofauna of the eastern-African forests. In: J.C. Lovett & S.K. Wasser (eds.), *Biogeography and Ecology of the Rain Forests of Eastern Africa*. Cambridge University Press, Cambridge. Pp 173–202.

IUCN (2009). *2009 Red List of Threatened Species*. Version 2009.1. IUCN, Gland and Cambridge. www.iucnredlist.org/ [accessed September 2009].

Jensen, F.P., A.P. Tøttrup & K.D. Christensen (2005). The avifauna of coastal forests in southeast Tanzania. *Scopus* **25**: 1–22.

Kielland, J. (1990). *Butterflies of Tanzania*. Hill House Publishers, London.

Kielland, J. & N.J. Cordeiro (2000). Butterflies. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 225–234.

Kingdon, J. (1974). *East African Mammals. An Atlas of Evolution in Africa. Vol. 2B: Hares and Rodents*. University Chicago Press, Chicago.

Kingdon, J. (1984). *East African Mammals. An Atlas of Evolution in Africa. Vol. 2A: Insectivores and Bats*. University of Chicago Press, Chicago.

Kingdon, J. (2003). *The Kingdon Field Guide to East African Mammals*. Academic Press, London.

Larsen, T.B. (1996). *The Butterflies of Kenya and their Natural History*. Oxford University Press, Oxford.

Lehtinen, R.M., J.B. Ramanamanjato & J.G. Raveloarison (2003). Edge effects and extinction proneness in a herpetofauna from Madagascar. *Biodiversity and Conservation* **12**: 1357–1370.

Milledge, S.A.H. & R. Elibariki (2005). The Status of Logging in Southern Tanzania. TRAFFIC Technical report for CEPF. TRAFFIC East/Southern Africa, Dar es Salaam.

Milledge, S.A.H. & B.K. Kaale (2005). Bridging the Gap - Linking Timber Trade with Infrastructure Development in Southern Tanzania: Baseline data before completion of the Mkapa Bridge. TRAFFIC East/Southern Africa, Dar es Salaam. Pp. 1–120.

Milledge, S.A.H., I.K. Gelvas & A. Ahrends (2007). Forestry, Governance and National Development: Lessons learned from a logging boom in southern Tanzania. An overview. TRAFFIC East/Southern Africa/Tanzania Development Partners Group/Ministry of Natural Resources and Tourism, Dar es Salaam. Pp. 1–252

Mittermeier, R.A., P.R. Gil, M. Hoffmann, J. Pilgrim, T. Brooks, C.G. Mittermeier, J. Lamoreux & G.A.B. Da Fonseca (2004). *Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. Cemex, Mexico City.

Mlingwa, C.O.F., E.M. Waiyaki, L.A. Bennun & N.D. Burgess (2000). Birds. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 149–172.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca & J. Kent (2000). Biodiversity hotspots for conservation priorities. *Nature* **403**: 853–858.

Passmore, N.I. & V.C. Carruthers (1995). *South African frogs: a complete guide*. Southern Book Publishers, Johannesburg.

Poynton, J.C. (2000). Amphibians. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 201–210.

Rathbun, G. (2005). Afrotheria Specialist Group Website. www.calacademy.org/research/bmammals/afrotheria/ASG.html [accessed May 2007].

Rathbun, G. (2006). *Rhynchocyon cirnei*. In *2006 IUCN Red List of Threatened Species*. IUCN, Gland and Cambridge. www.iucnredlist.org [accessed May 2007].

Robinson, D.W. & S.K. Robinson (1999). Effects of selective logging on forest bird populations in a fragmented landscape. *Conservation Biology* **13**: 58–66.

Rodgers, W.A. & N.D. Burgess (2000). Taking conservation action. In N.D. Burgess & G.P. Clarke (eds.), *Coastal Forests of Eastern Africa*. IUCN Publications Services Unit, Cambridge. Pp. 317–334.

Schiøtz, A. (1999). *Treefrogs of Africa*. Edition Chimaira, Frankfurt am Main, Germany.

Sinclair, I. & P. Ryan (2003). *Birds of Africa South of the Sahara*. Struik Publishers, Cape Town.

Spawls, S., K.M. Howell, R. Drewes & J. Ashe (2002). *A Field Guide to the Reptiles of East Africa*. Academic Press, Hong Kong.

Stevenson, T. & J. Fanshawe (2002). *Field Guide to the Birds of East Africa*. T. & A.D. Poyser, London.

Vallan, D., F. Andreone, V.H. Raherisoa & R. Dolch (2004). Does selective wood exploitation affect amphibian diversity? The case of An'Ala, a tropical rainforest in eastern Madagascar. *Oryx* **38**: 410–417.

White, F. (1983). *The Vegetation of Africa. A Descriptive Memoir to Accompany the Unesco/AETFAT/UNSO Vegetation Map of Africa*. UNESCO, Paris.

White, E., N. Tucker, N. Meyers & J. Wilson (2004). Seed dispersal to revegetated isolated rainforest patches in North Queensland. *Forest Ecology and Management* **192**: 409–426.

Zimmerman, D.A., Turner, D.A. & D.J. Pearson (1996). *Birds of Kenya and Northern Tanzania*. Russel Friedman Books, Cape Town.

Appendix 1. List of mammal species for all Forest Reserves (taxonomy based on Kingdon, 2003.

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collecion no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
PRIMATES															
CERCOPITHECIDAE															
Papioninae															
Papio cynocephalus Linnaeus 1766	O	W	LC; CITES II		FT	FT	*			s				s	
Cercopithecinae															
Cercopithecus mitis Wolf 1822	F	W	LC; CITES II		FT	FT				s	s		s	s	
Chlorocebus pygerythrus (F. Cuvier 1821)	f	W	LC; CITES II		FT	FT	*	*	s	s	s		s	s	
GALAGONIDAE															
Otolemur crassicaudatus (É. Geoffroy Saint-Hilaire 1812)	f	W	LC; CITES II		FT	FT		*	0	s			0	0	
Otolemur garnettii (Ogilby 1838)	f	W	LC; CITES II		FT	FT	0	0							H
Galago sp.	-	-	-		FT	FT		0			0	0			
CHIROPTERA															
NYCTERIDAE															
Nycteris grandis Peters 1865	O	W	LC	26113	FT	KMH		X							
Nycteris hispida (Schreber 1774)	O	W	LC	26111	FT	KMH								X	
PTEROPODIDAE															
Epomophorus wahlbergi (Sundevall 1846)	f	W	LC	26108	FT	KMH				X					

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
RHINOLOPHIDAE															
Rhinolophinae															
Rhinolophus hildebrandti Peters 1878	O	W	LC	26112 26119	FT	KMH								X	
VESPERTILIONIDAE															
Scotoecus hirundo (de Winton 1899)	O	W	LC		FT	FT				X					
Scotoecus sp.	-	-	-	26109-10	FT	KMH				X					
HYRACOIDEA															
PROCAVIDAE															
Dendrohyrax sp.	-	-	-		FT	FT									H
INSECTIVORA															
SORICIDAE															
Crocidura sp.1	-	-	-	26661-2 26670 26673 26676	FT	KMH	X			X			X	X	H
Crocidura sp.2	-	-	-	26663-9 26671-2 26674-5	FT	KMH	X	X	X	X			X	0	H
MACROSCELIDEA															
MACROSCELIDIDAE															
Rhynchocyoninae															
Rhynchocyon cirnei Peters 1847	f	W	NT		FT	FT	s	*		s	s	s		s	H
LAGOMORPHA															
LEPORIDAE															
Lepus saxatilis Cuvier 1823	O	W	LC		FT	FT	0	*	0	s		0	0	0	
Pronolagus rupestris (A. Smith 1834)	O	W	LC		FT	FT								0	

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
RODENTIA															
SCIURIDAE															
Heliosciurus mutabilis Peters 1852)	f	W	LC		FT	FT		*		s		X			
Paraxerus flavovittis (Peters 1852)	O	W	LC		FT	FT			s			X			H
Paraxerus palliates	F	W	LC		FT	FT	s	*		s	s				
HYSTRICIDAE															
Hystrix cristata Linnaeus 1758	O	W	LC		FT	FT	*	*	0	0				0	
MUROIDEA															
Tatera robusta (Cretzschmar 1826)	f	O	LC	26811 26815	FT	KMH								X	
Cricetomyinae															
Beamys hindei Thomas 1909	f	EACF plus few other sites	LC	26792-3 26801	FT	KMH	X	X		X	X		X		
MURIDAE															
Acomys spinosissimus Peters 1852	O	W	LC	26799 26804-5 26807	FT	KMH			X	X		X	X	X	
Grammomys dolichurus (Smuts 1832)	f	W	LC	26794 26802 26812 26814	FT	KMH	X			X				X	
Mastomys natalensis Smith 1834	O	W	LC	26795-6 26803 26806 26808-10	FT	KMH	X	X	X	X		X	X	X	
Mus minutoides Smith 1834	O	W	LC	26797	FT	KMH	X								
Mus sp.	-	-	-	26798	FT	KMH			X						

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Praomys sp.	-	-	-	26800	FT	KMH				X					
Rattus alexandrinus (Linnaeus 1758)	O	W	NL	26813	FT	KMH								X	
THRYONOMYIDAE															
Thryonomys swinderianus (Temminck 1827)	O	W	LC		FT	FT			0		*	0			H
CARNIVORA															
CANIDAE															
Canis adustus Sundevall 1847	O	W	LC		FT	FT	*	*	*	*					
MUSTELIDAE Latrinae															
Aonyx capensis(Schinz 1821)	O	W	LC; CITES II		FT	FT		0						0	
HERPESTIDAE															
Atilax paludinosus (Cuvier 1829)	O	W	LC		FT	FT				0			0	0	
Helogale parvula (Sundevall 1847)	O	W	LC		FT	FT			0						
Herpestes (*Galerella*) *sanguinea* (Rüppell 1836)	O	W	NL		FT	FT								0	
Mungos mungo(Gmelin 1788)	O	W	LC		FT	FT								s	
HYAENIDAE															
Crocuta crocuta Erxleben 1777	O	W	LC		FT	FT	*	*	0	0			0	0	
VIVERRIDAE															
Civettictis civetta (Schreber 1776)	f	W	LC		FT	FT	*	*	0	0			0	0	H
Genetta genetta (Linnaeus 1758)	O	W	LC		FT	FT	*	*		0					H
FELIDAE															
Felis caracal Schreber 1776	O	W	CITES II		FT	FT				0					
Panthera leo (Linnaeus 1758)	O	W	VU; CITES II		FT	FT	*	*	*	*	*	*		0	

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Panthera pardus panthera (Linnaeus 1758)	O	W	NT; CITES I		FT	FT	*	*	0	*				0	
PHOLIDOTA															
MANIDAE															
Smutsia temminckii alexandrinus Smuts 1832	O	W	NL		FT	FT		*						*	
TUBULIDENTATA															
ORYCTEROPODIDAE															
Orycteropus afer (Pallas 1766)	O	W	LC		FT	FT								s	
HYRACOIDEA															
PROCAVIDAE															
Heterohyrax brucei (Gray 1868)	-	-	NL		FT	FT	*	*						0	
PROBOSICIDEA															
ELEPHANTIDAE															
Loxodonta africana (Blumenbach 1797)	O	W	NT, CITES II		FT	FT								0	
PERISSODACTYLA															
EQUIDAE															
Equus burchelli Boddaert 1785	O	W	LC		FT	FT								0	
ARTIODACTYLA															
HIPPOPOTAMIDAE															
Hippopotamus amphibius Linnaeus 1758	O	W	VU A4cd; CITES II		FT	FT								*	
SUIDAE															
Phacochoerus africanus (Gmelin 1788)	O	W	LC		FT	FT								0	
Potamochoerus larvatus (F. Cuvier 1822)	f	W	LC		FT	FT	*	*	*	0	0		0	0	H

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtinika	Mtuli Hinju	Makonde III	Ndechela	Hunted
BOVIDAE															
Bovinae															
Syncerus caffer (Sparman 1779)	O	W	LC		FT	FT								0	
Tragelaphus scriptus (Pallas 1766)	O	W	LC		FT	FT					*				
Tragelaphus strepsiceros (Pallas 1766)	f	W	LC		FT	FT								s	
Antilopinae															
Cephalophus monticola (Thunberg 1789)	F	W	LC; CITES II		FT	FT		0			*	0		0	H
Cephalophus natalensis A. Smith 1834	F	W	LC		FT	FT		*	0	0					H
Hippotragus niger (Harris 1838)	O	W	LC		FT	FT								*	H
Madoqua kirkii (Gunther 1880)	f	W	LC		FT	FT					0	0			
Neotragus moschatus (von Dueben 1846)	F	W	LC		FT	FT	0	0							
Oreotragus oreotragus (Zimmerman 1783)	O	W	LC		FT	FT				0				*	

Category: F = forest dependent or specialist; f = forest dwelling or generalist; O = non-forest or forest visitor (Kingdon 1974, 1984 and 2003; Cockle *et al.*, 1998; Burgess *et al.*, 2000)

Distribution: W = widespread; CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (based on Burgess & Clarke, 2000); SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E Africa (Kingdon 1974, 1984 and 2003)

Conservation status: NL = not listed; CR = critically endangered; EN = endangered; VU = vulnerable; NT = lower risk, near threatened; CD = lower risk, conservation dependent; LC = lower risk, least concerned; DD = data deficient (IUCN, 2009); CITES I = threatened with extinction and excluded from international trade; CITES II = not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2009)

Collected/identified by: FT = Frontier-Tanzania field team: Ms. Rosalind Salter, Mr. Oisin Sweeney, Mr. Michael Cutts, Mr. Hassani Abedi and Mr. Mohammed Ali; KMH = Prof. Kim H. Howell; ? = awaiting ID confirmation

Site data: X = capture record; X = confirmed by specimen; s = sight record; 0 = calls or signs; * = reports of local people; H = hunted

Appendix 2. List of bird species for all Forest Reserves (taxonomy based on Zimmerman et al.*, 1996; Stevenson & Fanshawe, 2002; and Sinclair & Ryan, 2003)*

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kambonaa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
CICONIIFORMES												
SCOPIDAE												
Scopus umbretta (Gmelin 1789)	O	W	LC				X		X		X	
ANSERIFORMES												
ANATIDAE												
Dendrocygna viduata (Linnaeus 1766)	O	W	LC						X			
Nettapus auritus (Boddaert 1783)	O	W	LC						X			
FALCONIFORMES												
ACCIPITRIDAE												
Accipiter tachiro (Daudin 1800)	f	W	LC CITES II	X	X							
Aquila verreauxii Lesson 1831	O	W - first record for Mtwara R.	LC CITES II				X					
Aviceda cuculoides Swainson 1837	f	W	LC CITES II		X							
Circaetus cinereus Vieillot 1818	O	W	LC CITES II			X	X					
Circaetus fasciolatus Kaup 1850	f	W	NT CITES II	X		X		X				
Circaetus pectoralis Smith 1829	O	W	LC CITES II	X	X	X	X	X	X	X	X	
Elanus caeruleus (Desfontaines 1789)	O	W	LC; CITES II					X	X			
Gypohierax angolensis (J. F. Gmelin 1788)	f	W	LC CITES II	X			X					

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kamborraa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Hieraaetus spilogaster (Bonaparte 1850)	O	W	LC CITES II								X	
Kaupifalco monogrammicus (Temminck 1824)	O	W	LC CITES II	X	X	X	X	X	X	X	X	
Lophaetus occipitalis (Daudin 1800)	f	W	LC CITES II				X					
Macheiramphus alcinus Westerman 1851	f	W	LC CITES II								X	
Polyboroides typus Smith 1829	f	W	LC CITES II	X	X		X				X	
Stephanoaetus coronatus (Linnaeus 1766)	F	W	LC CITES II		X							
Terathopius ecaudatus (Daudin 1800)	O	W	LC CITES II	X	X	X	X	X	X	X	X	
FALCONIDAE												
Falco dickinsoni Sclater 1864	O	W	LC CITES II								X	
Falco peregrinus Tunstall 1771	O	W	LC CITES I			X		X				
GALLIFORMES												
PHASIANIDAE												
Pternistes (or *Francolinus*) *afer* Bocage, 1893	O	W	LC		X							
Pternistes (or *Francolinus*) *hildebrandti* Cabanis 1978	f	W	LC		X	X				X	X	
NUMIDIDAE												H
Guttera pucherani (Hartlaub 1861)	F	W	LC									
Numida meleagris (Linnaeus 1758)	O	W	LC		X			X			X	

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kambonaa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
GRUIFORMES												
RALLIDAE												
Amauromis flavirostris (Swainson1837)	O	W	LC						X			
CHARADRIIFORMES												
JACANIDAE												
Actophilomis africanus (J. F. Gmelin 1789)	O	W	LC						X			
COLUMBIFORMES												
COLUMBIDAE												
Streptopelia capicola (Sundevall 1857)	O	W	LC	X	X	X	X	X	X	X	X	
Streptopelia semitorquata (Ruppell 1837)	f	W	LC	X	X	X	X	X	X	X	X	
Streptopelia senegalensis (Linnaeus 1766)	O	W	NL								X	
Treron calva (Temminck 1808)	f	W	LC	X	X		X				X	
Turtur chalcospilos (Wagler 1827)	f	W	LC	X	X	X	X	X	X	X	X	
Turtur tympanistria (Temminck 1809)	f	W	LC	X	X			X	X		X	
PSITTACIFORMES												
PSITTACIDAE												
Agapornis lilianae Shelley 1894	O	W	NT CITES II								X	
Poicephalus cryptoxanthus (Peters 1854)	f	SE Africa	LC CITES II		X		X	X	X		X	
MUSOPHAGIFORMES												
MUSOPHAGIDAE												
Tauraco porphyreolophus (Vigors 1831)	f	W	LC CITES II								X	
CUCULIFORMES												
CUCULIDAE												
Centropus burchelli Swainson 1838	f	W	NL	X	X	X	X	X	X	X	X	
Ceuthmochares australis Sharpe 1873	f	W	NL			X	X					

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kamborraa	Makonde I	Makonde II	Mkunya	Mtinika	Mtuli Hinju	Makonde III	Ndechela	Hunted
Chrysococcyx cupreus (Shaw 1792)	f	W	LC		X						X	
Chrysococcyx klaas (Stephens 1815)	f	W	LC				X				X	
STRIGIFORMES												
STRIGIDAE												
Bubo africanus (Temminck 1821)	O	W	LC CITES II			X	X				X	
Glaucidium capense (Smith 1834)	f	W	LC CITES II				X					
Strix woodfordii (A. Smith 1834)	f	W - first record for Mtwara R.	LC CITES II		X		X	X	X	X		
Tyto alba (Scopoli 1769)	O	W	LC CITES II									H
CAPRIMULGIFORMES												
CAPRIMULGIDAE												
Caprimulgus pectoralis Cuvier 1816	f	W	LC	X	X	X	X	X	X	X	X	
APODIFORMES												
APODIDAE												
Apus affinis (Gray 1830)	O	W	LC				X			X		
Apus caffer (Lichtenstein 1823)	O	W	LC			X			X	X		
Cypsiurus parvus (Lichtenstein 1823)	f	W	NL	X								
Neafrapus boehmi (Schalow 1882)	f	W	LC				X				X	
TROGONIORMES												
TROGONIDAE												
Apaloderma narina (Stephens 1815)	f	W	LC	X				X	X			
CORACIIFORMES												
ALCEDINIDAE												
Halcyon albiventris (Scopoli 1786)	f	W	LC	X	X	X	X	X	X	X	X	

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kambonaa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Halcyon chelicuti (Stanley 1814)	O	W	LC	X		X	X				X	
Ispidina picta (Boddaert 1783)	f	W	NL	X	X		X		X			
Megaceryle maxima (Pallas 1769)	O	W	LC				X					
MEROPIDAE												
Merops boehmi Reichenow 1882	f	W	LC				X	X	X			
Merops pusillus Muller 1776	O	W	LC	X	X	X	X	X	X	X	X	
CORACIIDAE												
Coracias caudata Linnaeus 1766	O	W	LC								X	
Coracias spatulata Trimen 1880	O	W	LC			X						
PHOENICULIDAE												
Phoeniculus purpureus (Miller 1784)	f	W	LC			X	X	X			X	
Rhinopomastus cyanomelas (Vieillot 1819)	O	W	LC			X	X				X	
BUCEROTIDAE												
Bucorvus leadbeateri (Vigors 1825)	O	W	NL	X			X			X	X	
Bycanistes bucinator (Temminck 1824)	f	W	LC								X	
Tockus alboterminatus (Buttikofer 1889)	f	W	LC		X		X	X	X		X	
Tockus nasutus (Linnaeus 1766)	O	W	LC								X	
PICIFORMES												
CAPITONIDAE												
Lybius melanopterus (Peters 1854)	f	E Africa	LC			X	X					
Pogoniulus bilineatus (Sundevall 1850)	f	W	LC	X	X	X	X	X	X	X	X	
INDICATORIDAE												
Indicator indicator (Sparrman 1777)	O	W	LC		X		X				X	
PICIDAE												
Campethera abingoni (Smith 1836)	f	W	LC			X	X	X				

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kambonaa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Dendropicos fuscescens (Vieillot 1818)	f	W	LC			X	X				X	
Dendropicos namaquus (Lichtenstein 1793)	f	W	NL				X				X	
PASSERIFORMES												
EURYLAIMIDAE												
Smithornis capensis (Smith, 1839)	F	W	LC		X		X	X	X	X		
MOTACILLIDAE												
Anthus cinnamomeus Ruppell 1840	O	W	NL			X						
Motacilla aguimp Dumont 1821	O	W	LC				X					
HIRUNDINIDAE												
Hirundo abyssinica Guerin-Meneville 1843	O	W	LC			X			X		X	
Hirundo smithii Leach 1818	O	W	LC	X		X	X				X	
Psalidoprocne holomelas (Sundevall 1850)	f	W - first record for Mtwara R.	NL	X	X	X	X		X			
Psalidoprocne orientalis Reichenow 1889	O	W	NL								X	
PYCNONOTIDAE												
Andropadus importunes (Vieillot 1818)	f	W	LC	X	X	X	X	X			X	
Chlorocichla flaviventris (Smith 1834)	f	W	LC		X	X	X	X	X	X	X	
Nicator gularis Hartlaub & Finsch 1870	f	SE Africa	LC	X	X		X	X	X	X	X	
Phyllastrephus flavostriatus (Sharpe 1876)	F	SE Africa	LC					X				
Phyllastrephus fischeri (Reichenow 1879)	F	W	LC					X				
Pycnonotus barbatus (Desfontaines 1789)	O	W	LC	X	X	X	X	X	X	X	X	
TIMALIIDAE												
Turdoides jardineii (Smith 1836)	O	W	LC				X				X	

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kambonaa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
TURDIDAE												
Cercomela familiaris (Stephens 1826)	O	W	LC				X					
Cercotrichas quadrivirgata (Reichenow 1879)	f	W	NL	X	X	X	X	X	X	X	X	
Cossypha heuglini Hartlaub 1866	O	W	LC		X	X	X				X	
Thamnolaea cinnamomeiventris Lafresnaye 1836	O	W	NL				X				X	
Sheppardia gunningi Haagner 1909	F	CF and a few other sites	NT					X				
Turdus libonyanus (Smith 1836)	O	W	LC		X		X					
MUSCICAPIDAE												
Bias musicus (Vieillot 1818)	f	W	LC					X				
Erythrocercus livingstonei Gray 1870	f	SE Africa	LC		X	X	X	X	X	X	X	
Muscicapa caerulescens (Hartlaub 1865)	f	W	LC		X		X	X	X		X	
Muscicapa striata (Pallas 1764)	O	W	LC								X	
Terpsiphone viridis (Muller 1776)	f	W	LC	X	X	X	X	X	X	X	X	
Trochocercus cyanomelas (Vieillot 1818)	F	W	LC	X			X	X	X	X		
SYLVIIDAE												
Apalis flavida (Strickland 1852)	f	W	LC		X	X	X			X	X	
Camaroptera brachyuran (Vieillot 1820)	f	W	LC	X	X	X	X	X	X	X	X	
Cisticola erythrops (Hartlaub 1857)	O	W	LC		X						X	
Heliolais erythroptera (Jardine 1849)	O	W	LC								X	
Prinia subflava (J. F. Gmelin 1789)	O	W	LC	X	X	X	X	X	X	X	X	
Sylvietta whytii (Shelley 1894)	f	W - first record for Mtwara R.	LC	X	X		X					

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kamborraa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
ZOSTEROPIDAE												
Zosterops senegalensis Bonaparte 1850	f	W	LC						X		X	
PLATYSTEIRIDAE												
Batis reichenowi Grote 1911	F	CF	NL					X				
Batis soror Reichenow 1903	f	SE Africa	LC	X	X	X	X			X	X	
Platysteira peltata Sundevall 1850	f	W	LC	X	X	X	X	X	X	X	X	
PRIONOPIDAE												
Prionops retzii Wahlberg 1856	f	W	LC	X	X		X			X	X	
MALACONOTIDAE												
Dryoscopus cubla (Shaw 1809)	f	W	LC	X	X	X	X	X	X	X	X	
Laniarius aethiopicus (J. F. Gmelin 1788)	f	W	LC	X	X	X	X	X	X	X	X	
Malaconotus blanchoti Stephens 1826	f	W	LC	X			X				X	
Malaconotus quadricolor (Cassin 1852)	f	W	NL			X		X		X		
Malaconotus sulfureopectus (Lesson 1830)	f	W	LC		X	X		X	X	X		
Tchagra australis (Smith 1836)	f	W	LC	X	X	X	X	X	X	X	X	
Tchagra senegala (Linnaeus 1766)	O	W	LC	X	X		X				X	
CAMPEPHAGIDAE												
Campephaga flava Vieillot 1817	f	W	LC	X	X		X			X	X	
Coracina pectoralis (Jardine & Selby 1828)	O	W	LC		X		X				X	
DICRURIDAE												
Dicrurus adsimilis (Bechstein 1794)	O	W	LC	X	X	X	X	X	X	X	X	
Dicrurus ludwigii (Smith 1834)	f	W	LC		X		X		X		X	
ORIOLIDAE												
Oriolus auratus Vieillot 1817	f	W	LC	X	X	X	X				X	

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kambonaa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Oriolus lavatus Lichtenstein 1823	f	W	LC	X	X		X		X	X		
CORVIDAE												
Corvus albicollis Latham 1790	O	W - first record for Mtwara R.	LC			X					X	
Corvus albus Muller 1776	O	W	LC	X	X	X	X	X	X	X	X	
STURNIDAE												
Cinnyricinclus leucogaster (Boddaert 1783)	O	W	LC								X	
Lamprotornis elisabeth (Stresemann 1924)	f	W	LC		X						X	
Onychognathus morio (Linnaeus 1766)	O	W	LC				X				X	
NECTARINIIDAE												
Chalcomitra amethystine (Shaw 1812)	f	W	NL	X	X		X					
Chalcomitra senegalensis (Linneaus 1766)	O	W	NL								X	
Cinnyris talatala (Smith 1836)	f	W	NL			X	X					
Cyanomitra olivacea (Smith 1840)	f	W	NL	X	X	X	X	X	X	X	X	
Hedydipna collaris (Vieillot 1819)	f	W	NL	X	X	X	X	X	X	X	X	
PASSERIDAE												
Petronia superciliaris (Blyth 1845)	O	W	LC		X		X				X	
Plocepasser mahali Smith 1836	O	W - first record for Mtwara R.	LC								X	
PLOCEIDAE												
Amblyospiza albifrons (Vigors 1831)	f	W	LC				X					
Anaplectes rubriceps (Sundevall 1850)	O	W	LC				X				X	
Euplectes afer (J. F. Gmelin 1789)	O	W	LC				X					

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kambonaa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Euplectes hordeaceus (Linnaeus 1758)	O	W	LC		X		X					
Euplectes orix (Linnaeus 1758)	O	W	LC		X							
Ploceus bicolour Vieillot 1819	f	W	LC				X	X	X	X	X	
Ploceus cucullatus (Muller 1776)	O	W	LC		X							
Ploceus intermedius Ruppell 1845	O	W	LC		X					X		
Ploceus ocularis Smith 1839	f	W	LC				X				X	
Ploceus subaureus Smith 1839	O	SE Africa	LC				X					
Quelea erythrops (Hartlaub 1848)	O	W	LC								X	H
ESTRILDIDAE												
Estrilda astrild (Linnaeus 1758)	O	W	LC	X	X							
Hypargos niveoguttatus (Peters 1868)	f	W	LC	X	X	X	X	X	X	X	X	
Lagonosticta rubricata (Lichtenstein 1823)	O	W	LC	X	X	X	X	X	X	X	X	
Mandingoa nitidula (Hartlaub 1865)	f	W	LC		X		X	X	X			
Pyrenestes minor Shelley 1894	f	W - first record for Mtwara R.	LC				X					
Pytilia afra (J. F. Gmelin 1789)	O	W	LC			X	X			X		
Pytilia melba (Linnaeus 1758)	O	W	LC	X	X	X	X	X	X	X	X	
Spermestes bicolour (Fraser 1843)	O	W	NL	X			X			X	X	
Spermestes cucullata	O	W	NL	X	X	X	X					
Uraeginthus angolensis (Linnaeus 1758)	O	W	LC		X	X	X				X	
Vidua chalybeate (Muller 1776)	O	W	LC			X						
Vidua obtuse (Chapin 1922)	O	W	LC		X		X				X	
FRINGILLIDAE												
Serinus mozambicus (Muller 1776)	O	W	LC	X	X	X	X	X	X	X	X	

Scientific name	Category	Distribution	Conservation Status (IUCN)	Kambonaa	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Serinus reichardi (Reichenow 1882)	f	W	LC			X	X					
EMBERIZIDAE												
Emberiza cabanisi (Reichenow 1875)	O	W	LC			X					X	
Emberiza tahapisi Smith 1836	O	W	LC		X	X	X				X	

Category: F = forest dependent or specialist; f = forest dwelling or generalist; O = non-forest or forest visitor (Zimmerman *et al.*, 1996; Mlingwa *et al.*, 2000; Stevenson & Fanshawe, 2002; Sinclair & Ryan, 2003)

Distribution: W = widespread; CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (based on Burgess & Clarke, 2000);
SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E (Zimmerman *et al.*, 1996; Stevenson & Fanshawe, 2002; Sinclair & Ryan, 2003)

Conservation status: NL = Not listed; CR = critically endangered; EN = endangered; VU = vulnerable; NT = lower risk, near threatened; CD = lower risk, conservation dependent; LC = lower risk, least concerned; DD = data deficient (IUCN, 2009); CITES I = threatened with extinction and excluded from international trade; CITES II = not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2009)

Collected/identified by: Specimens collected and identified by Jacob Kiure except for Pyrenestes Minor (KMH 26586) which was identified by Kim Howell.

Site data: X = capture record; X = confirmed by specimen; H = hunted

Appendix 3. List of reptile species for all Forest Reserves (taxonomy based on Spawls et al., 2002; species identification by Frontier-Tanzania field team, Kim M. Howell, Michele Menegon & Don G. Broadley).

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtui Hinju	Makonde III	Ndechela	Hunted
TESTUDINES															
TESTUDINIDAE															
Geochelone pardalis (Bell 1828)	O	W	CITES II		FT	FT	0							0	H
PELOMEDUSIDAE															
Pelomedusa subrufa (Bonnaterre 1789)	O	W	NL		FT	FT								X	
SAURIA															
GEKKONIDAE															
Hemidactylus mabouia (Moreau de Jonnes 1818)	O	W	NL	26731	FT	DGB		X							
AGAMIDAE															
Agama agama (Linnaeus 1758)	O	W	NL		FT	FT				X					
Agama mossambica Peters 1854	O	W	NL	26739; 26743?; 26751	FT	DGB, KMH			X	X	X		X	X	
VARANIDAE															
Varanus albigularis Daudin 1802	O	W	CITES II		FT	FT	0							*	H
Varanus niloticus Linnaeus 1758	O	W	CITES II		FT	FT				s		s			
SCINCIDAE															
Panaspis sp.	-	-	-	26736	FT	DGB		X							
Trachylepis maculilabris Gray 1845	O	W	NL	26745?	FT	KMH					X				
Trachylepis megalura Peters 1878	O	W	NL		FT	FT			X	X					
Trachylepis sp.	-	-	-		FT	FT			s	s			s	s	

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Trachylepis striata Peters 1844	O	W	NL		FT	FT								X	
Trachylepis varia Peters 1867	O	W	NL		FT	FT				X					
LACERTIDAE															
Ichnotropis squamulosa Peters 1854	O	W	NL		FT	FT		X							
Latastia sp.	-	-	-	26737?	FT	KMH		X							H
GERRHOSAURIDAE															
Gerrhosaurus nigrolineatus Hallowell 1857	O	W	NL	26738	FT	DGB		X	X						
Platysaurus maculates Broadley 1965	O	N Mozambique and Masasi district in SE Tanzania	NL	26749?	FT	KMH								X	
CORDYLIDAE															
Cordylus tropidosternum Cope 1869	f	W	CITES II	26730?	FT	KMH	X								
SERPENTES															
BOIDAE															
Python natalensis Smith 1840	O	W	CITES II		FT	FT	0			*					H
COLUBRIDAE															
Crotaphopeltis hotamboeia (Laurenti 1768)	O	W	NL	26740	FT	DGB			X						
Dasypeltis medici Bianconi 1859	f	W	NL	26732	FT	DGB		X							
Lamprophis capensis Dumeril & Bibron 1854	O	W	NL	26735	FT	DGB		X		X					
Lycophidion capense subsp. *capense* Smith 1831	O	W	NL	26733	FT	DGB		X							
Mehelya nyassae (juv.) Günther 1888	O	W	NL	26741	FT	DGB			X						

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtniko	Mtuli Hinju	Makonde III	Ndechela	Hunted
Philothamnus semivariegatus Smith 1847	O	W	NL	26744	FT	DGB				X					
Psammophis mossambicus Broadley 2002	O	W	NL		FT	FT							s		
Psammophis orientalis Broadley 1977	O	W	NL	26746	FT	DGB				X			X	s	
Thelotornis capensis Smith 1849	O	W (first record for Tanzania; awaiting ID confirmation)	NL	26748?	FT	MM			X						
Thelotornis mossambicanus Broadley 2001	O	W	NL	26734; 26747	FT	DGB		X		X			s		
VIPERIDAE															
Bitis arietans Merrem 1820	O	W	NL	26786?	FT	KMH		X							
Causus defilippii Jan 1862	O	W	NL	26742; 26750?	FT	DGB, KMH				X					X

Category: F = forest dependent or specialist; f = forest dwelling or generalist; O = non-forest or forest visitor (Howell, 1993; Broadley & Howell, 2000; Spawls *et al.*, 2002)

Distribution: W = widespread; CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (based on Burgess & Clarke, 2000); SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E Africa (Howell, 1993; Spawls *et al.*, 2002)

Conservation status: NL = not listed; CR = critically endangered; EN = endangered; VU = vulnerable; NT = lower risk, near threatened; CD = lower risk, conservation dependent; LC = lower risk, least concerned; DD = data deficient (IUCN, 2009); CITES I = threatened with extinction and excluded from international trade; CITES II = not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2009)

Collected/identified by: FT = Frontier-Tanzania field team: Ms. Rosalind Salter, Mr. Oisin Sweeney, Mr. Michael Cutts, Mr. Hassani Abedi and Mr. Mohammed Ali; DGB = Dr. Don G. Broadley; KMH = Prof. Kim H. Howell; MM = Michele Menegon; ? = awaiting ID confirmation

Site data: X = capture record; X = confirmed by specimen; s = sight record; 0 = calls or signs; * = reports of local people; H = hunted

Appendix 4. List of Amphibian species for all Forest Reserves (taxonomy based on Passmore & Carruthers, 1995 and Channing, 2001; species identification by Kim M. Howell)

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
ANURA														
ARTHROLEPTIDAE														
Arthroleptis stenodactylus Pfeffer 1893	f	W	LC	26860-1; 26864-5; 26869-70; 26872; 26875; 26879; 26893	FT	KMH	X	X	X	X			X	X
Arthroleptis xenodactyloides Hewitt 1933	f	W	LC	26859; 26866; 26868; 26880	FT	KMH	X	X		X			X	
Arthroleptis sp.	-	-	-	26855-6	FT	KMH	X							
BUFONIDAE														
Bufo maculatus Hallowell 1854	O	W	NL	26892	FT	KMH							X	
Bufo sp.	-	-	-	26858	FT	KMH	X							
Mertensophryne micranotis (Loveridge 1925)	f	EACF lowland	LC	26871	FT	KMH			X					
HEMISOTIDAE														
Hemisus marmoratus	O	W	LC	26873	FT	KMH				X				
HYPEROLIIDAE														
Afrixalus fornasini (Bianconi 1849)	O	W	LC	26881-2	FT	KMH		X		X		X		
Afrixalus sp.	-	-	-	26885	FT	KMH				X				
Hyperolius punticulatus Pfeffer 1893	f	EA	NL	26862-3; 26889, 91	FT	KMH	X					X		
Hyperolius sp.	-	-	-	26890	FT	KMH						X		
Kassina sp.	-	-	-	26901	FT	KMH								X
Leptopelis flavomaculatus (juv) (Günther 1864)	f	W	LC	26883-4	FT	KMH				X		X		
MICROHYLIDAE														
Breviceps mossambicus Peters 1854	O	W	LC	26867	FT	KMH		X						

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no. (KMH)	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtinika	Mtuli Hinju	Makonde III	Ndechela
PIPIDAE														
Xenopus muelleri(Peters 1844)	O	W	LC	26857; 26888	FT	KMH	X			X		X		
RHACOPHORIDAE														
Chiromantis xerampelina Peters 1854	O	W	LC	26886; 26900	FT	KMH					X			X
RANIDAE														
Ptychadena anchietae(Bocage 1868)	O	W	LC	26874	FT	KMH				X				
Ptychadena mossambica (Peters 1854)	O	W	LC	26887; 26899	FT	KMH						X		X
Ptychadena oxyrhynchus(Smith 1849)	O	W	LC	26895; 26905	FT	KMH								X
Ptychadena sp.	-	-	-	26896	FT	KMH								X
Phrynobatrachus mababiensis FitzSimons 1932	O	W	LC	26894; 26898 26902	FT	KMH								X
Phrynobatrachus natalensis (Smith 1849)	O	W	LC	26897; 26903-4	FT	KMH		X						X
Phrynobatrachus sp.1	-	-	-	26876-7	FT	KMH				X				
Phrynobatrachus sp.2	-	-	-	26878	FT	KMH				X				

Category: F = forest dependent or specialist; f = forest dwelling or generalist; O = non-forest or forest visitor (Passmore & Carruthers, 1995; Schiøtz, 1999; Poynton, 2000; Channing, 2001); ? = awaiting ID confirmation

Distribution: W = widespread; CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (based on Burgess & Clarke, 2000); SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa= species with limited ranges in E Africa (Passmore & Carruthers, 1995; Schiøtz, 1999; Channing, 2001)

Conservation status: NL = not listed; CR = critically endangered; EN = endangered; VU = vulnerable; NT = lower risk, near threatened; CD = lower risk, conservation dependent; LC = lower risk, least concerned; DD = data deficient (IUCN, 2009); CITES I = threatened with extinction and excluded from international trade; CITES II = not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2009)

Collected/identified by: FT = Frontier-Tanzania field team: Ms. Rosalind Salter, Mr. Oisin Sweeney, Mr. Michael Cutts, Mr. Hassani Abedi and Mr. Mohammed Ali; KMH = Prof. Kim H. Howell; ? = awaiting ID confirmation

Site records: X = capture record; X = confirmed by specimen.

Appendix 5. List of butterfly species for all Forest Reserves (taxonomy based on Kielland, 1990; Larsen, 1996; and Davenport, 2001; species identification by Frontier-Tanzania field team & Tim Davenport).

Scientific name	Category	Distribution	Consservation Status (IUCN)	Collection no	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
PAPILIONOIDEA														
PAPILIONIDAE														
Papilio constantinus constantinus Ward 1871	f	W <1900m	NL	s_mt73	FT	TD					X			
Papilio demodocus demodocus Esper 1798	O	W	NL		FT	FT						s		
Papilio ophidicephalus ophidicephalus Oberthür 1878	O	W <2000m	NL		FT	FT					s			s
PIERIDAE														
Belenois thysa thysa Hopffer 1855	f	W	NL		FT	FT				X			X	
Catopsilia florella Fabricius 1775	O	W; migratory	NL		FT	FT								X
Colotis amata Calais Fabricius 1775	O	W; migratory	NL		FT	FT				X				
Colotis euippe omphale Linnaeus 1758	O	W <2000m	NL	s_mt3; s_mt27	FT	TD	X	X		X		X		X
Colotis Ione Godart 1819	O	W <1700m	NL		FT	FT							X	
Colotis sp.	-	-	-	s_mt59	FT	TD				X				
Eurema desjardinsi marshalli Boisduval 1833	O	W	NL		FT	TD	X	X						
Eurema hapale (Mabille 1882)	O	W	NL	s_mt13	FT	TD	X							
Eurema hecabe solifera Linnaeus 1758	O	W; migratory	NL	s_mt1	FT	TD	X	X		X				
Eurema regularis Butler 1876	O	W	NL	s_mt2	FT	TD	X							X
Eurema upembana Berger 1981	f	Tanzania DR Congo	NL	s_mt96	FT	TD								X
Leptosia alcesta inalcesta Stoll 1784	f	W <2000m	NL	s_mt94; s_mt33	FT	TD		X		X	X			X
Leptosia sp.	-	-	-	s_mt26	FT	TD		X						
Nepheronia thalassina Boisduval 1836	f	W <1800m	NL	s_mt93	FT	TD								X

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
LYCAENIDAE														
Alaena amazoula nyasana Boisduval 1847	O	W 900-1500m	NL	s_mt56	FT	TD				X				
Anthene lunulata Trimen 1894	O	W	NL		FT	FT		X					X	
Baliochila lipara Stempffer & Bennett 1953	f	W 500-1000m	NL		FT	FT			X					
Baliochila sp.	-	-	-	s_mt50	FT	TD			X					
Chloroselas sp.	O	-	-	s_mt82; s_mt90	FT	TD							X	
Euchrysops malathana Boisduval 1833	O	W	NL	s_mt55	FT	TD				X				
Hypolycaena pachalica Butler 1888	O	W <2000m	NL		FT	TD		X		X				
Pentila pauli nyassana Aurivillius 1898	f	W <1600m	NL		FT	TD	X						X	
Pentila sp.	-	-	-	s_mt14; s_mt89	FT	TD	X						X	
Zizeeria knysna (Trimen 1862)	O	W	NL	s_mt28; s_mt29 s_mt47; s_mt68 s_mt69; s_mt70 s_mt100	FT	TD		X		X	X			X
NYMPHALOIDEA														
NYMPHALIDAE														
Amauris ochlea ochlea Boisduval 1847	f	W <1700m	NL	s_mt6	FT	TD	X							
Danaus chrysippus chrysippus Linnaeus 1758	O	W	NL	s_mt15	FT	TD	X							
Bicyclus safitza Hewitson 1851	O	W	NL	s_mt4; s_mt91	FT	TD	X	X		X		X	X	X
Bicyclus sp.	-	-	-	s_mt51; s_mt53	FT	TD				X				
Bicyclus vulgaris Butler 1868	O	W <1500m	NL	s_mt25	FT	TD		X						
Coenyropsis bera Hewitson 1877	f	W	NL	s_mt34	FT	TD		X					X	
Gnophodes betsimena diversa 1833	F	W <2000m	NL	s_mt87	FT	TD							X	X
Melanitis leda africana (Drury 1773)	f	W	NL		FT	FT				X				

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
Ypthima asterope asterope (Klug, 1832)	O	W	NL	s_mt54	FT	TD				X				
Byblia anvatara acheloia Boisduval 1894	O	W; migratory	NL	s_mt49	FT	TD			X	X				X
Byblia sp.1	-	-	-	s_mt63; s_mt97	FT	TD				X				X
Charaxes achaemenes achaemenes Felder 1866	O	W	NL	s_mt102	FT	TD								X
Charaxes bohemian Felder & Felder 1859	f	W <2000m	NL	s_mt45	FT	TD			X					
Charaxes brutus alcyone Cramer 1779	f	W	NL		FT	FT	X							
Charaxes castor flavifasciatus Cramer 1775	f	W <2000m	NL	s_mt38	FT	TD		X						
Charaxes ethalion littoralis Boisduval 1847	O	W	NL	s_mt65; s_mt74 s_mt77; s_mt78	FT	TD				X	X			
Charaxes cithaeron kennethi Felder 1858	f	W <1700m	NL	s_mt10; s_mt36	FT	TD	X	X						
Charaxes tavatensis tavatensis Rothschild 1894	f	W	NL		FT	FT			X					
Charaxes ethalion littoralis Boisduval 1847	O	W <1800m	NL		FT	FT			X					
Charaxes guderiana Dewits 1879	f	W	NL	s_mt16; s_mt19; s_mt32; s_mt39; s_mt41	FT	TD	X	X		X				X
Charaxes howarthi Minig 1976	f	W	NL	s_mt31; s_mt40; s_mt101	FT	TD		X		X	X		X	X
Charaxes jasius saturnus Linnaeus 1767	O	W	NL		FT	FT								X
Charaxesjahlusa argynnides Trimen 1862	f	W <1500m	NL	s_mt62	FT	TD				X				
Charaxes macclounii Butler 1895	O	W	NL		FT	FT	X	X		X	X	X	X	
Charaxes protoclea azota Feisthamel 1850	F	W	NL	s_mt9; s_mt20; s_mt52; s_mt86	FT	TD	X			X			X	
Charaxes sp.1	-	-	-	s_mt98	FT	TD				X	X	X		X
Charaxes sp.2	-	-	-	s_mt61	FT	TD				X				X

Scientific name	Category	Distribution	Conservation Status (IUCN)	Collection no	Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtniko	Mtuli Hinju	Makonde III	Ndechela
Charaxes sp.3	-	-	-	s_mt21	FT	TD	X				X			
Charaxes sp.4	-	-	-	s_mt18	FT	TD	X							
Charaxes sp.5	-	-	-	s_mt48	FT	TD			X					
Charaxes varanes vologeses Cramer 1777	O	W	NL	s_mt22; s_mt24	FT	TD		X		X	X	X	X	
Euphaedra neophron littoralis Hopffer 1855	F	W	NL		FT	FT				s	s		s	s
Eurytela dryope angulata Cramer 1775	O	W	NL	s_mt46	FT	TD			X		X	X		
Euxanthe wakefieldi (Ward 1873)	F	W <2000m	NL	s_mt23	FT	TD		X					X	
Hamanumida daedalus Fabricius 1775	O	W	NL		FT	FT	s			s	s	s	s	s
Harma theobene blassi Doubleday 1848	F	W	NL	s_mt75	FT	TD					X		X	
Junonia hierta cebrene Fabricius 1798	O	W	NL	s_mt95	FT	TD								X
Junonia natalica Felder 1860	f	W	NL	s_mt8	FT	TD	X							
Junonia oenone oenone Linnaeus 1758	O	W	NL	s_mt57	FT	TD				X			X	
Junonia orithya madagascariensis Linnaeus 1758	O	W	NL	s_mt103	FT	TD								X
Junonia terea elgiva Drury 1773	f	W	NL	s_mt7	FT	TD	X						X	
Neptidopsis fulgurata platyptera Boisduval 1833	f	Tanzania, Kenya <700m	NL	s_mt71	FT	TD					X			
Neptis alta Overlaet 1955	F	W <2000m	NL		FT	FT						X	X	
Neptis jordani Neave 1910	O	W 400-1800m	NL	s_mt76	FT	TD					X		X	X
Neptis sp.	-	-	-	s_mt79; s_mt81	FT	TD						X	X	
Precis antilope Feisthamel 1850	O	W	NL	s_mt99	FT	TD								X
Salamis parhassus Drury 1782	f	W	NL		FT	FT					s			
Sallya amulia rosa Cramer 1777	f	W	NL	s_mt17; s_mt44	FT	TD	X	X						X
Acraea anacreon bomba Trimen 1868	f	W	NL		FT	FT				X				
Acraea epaea epitellus Cramer 1779	F	W	NL	s_mt12	FT	TD	X							

Scientific name	Category	Distribution	Consservation Status (IUCN)	Collection no		Collected by	ID by	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
Acraea sp.1	-	-	-		s_mt80	FT	TD						X		
Acraea sp.2	-	-	-		s_mt83	FT	TD							X	
HESPEROIDEA															
HESPERIIDAE															
Andronymus neander neander Plötz 1884	f	W; migratory	NL		s_mt35	FT	TD		X						
Borbo sp.	-	-	-		s_mt30	FT	TD		X						

Category: F = Forest dependent or specialist; f = Forest dwelling or generalist; O = Non-forest or forest visitor (Kielland, 1990; Larsen, 1996; KiellandCordeiro, 2000; Davenport, 2001)

Distribution: W = widespread; CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (based on Burgess & Clarke, 2000); SE Tanzania = species with limited ranges in SE Tanzania; SE Africa= species with limited ranges in SE Africa; E Africa= species with limited ranges in E Africa (Kielland, 1990; Larsen, 1996; Davenport, 2001)

Conservation status: NL = not listed; CR = critically endangered; EN = endangered; VU = vulnerable; NT = lower risk, near threatened; CD = lower risk, conservation dependent; LC = lower risk, least concerned; DD = data deficient (IUCN, 2009); CITES I = threatened with extinction and excluded from international trade; CITES II = not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2009)

Collected/identified by: FT = Frontier-Tanzania field team: Ms. Rosalind Salter, Mr. Oisin Sweeney, Mr. Michael Cutts, Mr. Hassani Abedi and Mr. Mohammed Ali; TD = Dr. Tim Davenport.

Sites: X = capture record; X = confirmed by specimen; s = sight record.