Kipunji in Ndundulu Forest, Tanzania

Distribution, Abundance and Conservation Status

The first census and assessment of the Udzungwa population

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For further information on kipunji, go to: www.kipunji.org

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Contents

Executive Summary

In 2005, "kipunji" became the first African monkey to be described for 25 years. It is known from two sites in southern Tanzania: Mount Rungwe and the Livingstone Mountains in the Southern Highlands, and Ndundulu Forest in the Udzungwa Mountains. From the outset, the conservation status of the two populations gave cause for concern. In the Udzungwa Mountains, preliminary surveys in 2004 had confirmed the presence of only 42 individuals from three groups, restricted to 3km^2 of forest. A more thorough assessment of status was therefore the most urgent conservation priority for this population.

From November 2005 to March 2006, we completed 50.5 survey-days in Ndundulu, Luhomero and Nyumbanitu Forests in order to assess the distribution, abundance and conservation status of the Udzungwa kipunji population. In March 2006, we subsequently carried out an intensive census of the population's core area, employing 3 survey teams over 7 days. We also conducted semi-structured interviews with local people, and began awareness-raising activities.

Our results indicate that the distribution of kipunji in the Udzungwa Mountains is restricted to an area of 7.2km^2 in southern Ndundulu Forest, from 1300-1750m a.s.l. Density is very low, and total abundance of the population is estimated at between 60-150 individuals. Kipunji were not found inside of the Udzungwa Mountains National Park, though they are present less than 2 km from its boundary.

Current anthropogenic threats to the population were also assessed, and found to be low. Nevertheless our study confirmed that kipunji is highly endangered in the Udzungwa Mountains, making continuous and long-term monitoring and conservation efforts necessary. The possible reasons for the low abundance are briefly discussed, but are poorly understood, and it is critically urgent that further research is undertaken into the challenging question of why the population is so endangered. Other recommendations are discussed and presented, including the development of community-based ecological monitoring, and the value of utilising kipunji as a flagship species for the conservation of their exceptionally rich forest habitat.

Acknowledgements

This project was carried out by a team comprising **Kitegile Amani** B.Sc. (KA), **Richard Laizzer** (RL), **Athumani Mndeme** (AM) and myself (TJ). The four of us completed all of the survey work, made all the observations and recorded all the data reported and used here. However all interpretations of the survey results - and any errors - contained in this report are of my own making.

We were ably assisted in the field by Isaya Chahe, Biko Kisambwe and Njohole Lubugo of Udekwa; by Martin Mlewa and Amos Lumagi of Mwaya and Mang'ula A; and by Danny Amandusi and Angonile Mwakila, TANAPA Rangers of the Udzungwa Mountains National Park (UMNP).

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Introduction

Kipunji: Discovery, Taxonomy and Nomenclature

The monkey known as 'kipunji' was first observed and recognised as a new species by scientists working for the Wildlife Conservation Society (WCS) in the Southern Highlands of Tanzania in December 2003 (Davenport, 2005). In July 2004, Richard Laizzer and I discovered a second population of kipunji while surveying for primates in the Udzungwa Mountains, 350 km east of the Southern Highlands site (Davenport & Jones, 2005). We subsequently learned of each other's finds and in May 2005 the new monkey was collaboratively announced to the world in the journal *Science* (Jones *et al.*, 2005).

In this initial article we described this monkey as a new species. Because of the extremely small number of individuals that we had been able to count in the field, we decided to make the description without obtaining a specimen. Despite having been advised by the International Commission on Zoological Nomenclature that this was an acceptable practice, it proved contentious to some zoologist colleagues (Timm *et al.*, 2005). Nevertheless, on the basis of the evidence available to us - detailed observations of morphology, ecology and behaviour, and sonographic analysis of vocalisations - we proposed full specific status. On the basis of its arboreality and black eyelids we placed it in the genus *Lophocebus*, a group of arboreal mangabeys endemic to equatorial Africa (Jones *et al.*, 2005). We proposed the scientific name *Lophocebus kipunji* and the vernacular name 'Highland mangabey'. The specific name '*kipunji*' was chosen because it is the word used for this animal by the Wanyakyusa people living around Mount Rungwe, in the Southern Highlands.

Then in December 2005 a farmer on Mount Rungwe killed a crop-raiding subadult male 'highland mangabey' in a trap, and gave the specimen to the WCS Southern Highlands team. Director Dr. Tim Davenport assembled a team comprising ecologists, anatomists and a geneticist to describe this first ever specimen of the new monkey. The astonishing results were published in *Science* in May 2006. Primarily on the basis of molecular analysis and cranial measurements, but also supported by ecology and biogeography, it was decided that this animal does not belong in *Lophocebus* but instead warrants the creation of a new genus - named *Rungwecebus* after the type locality (Davenport *et al*., 2006).

Such an analysis has not yet been carried out on a specimen from the Ndundulu population. Currently therefore, the Udzungwa and Southern Highland locations comprise the total known distribution of the species *Rungwecebus kipunji*, of the monospecific genus *Rungwecebus*. As suggested by Davenport *et al.* (2006), my Tanzanian colleagues and I have adopted the simple vernacular name "kipunji" to refer to this genus and species.

The Udzungwa Census: Rationale, Objectives and Achievements

The 2005 description of kipunji in *Science* summarised what little information existed on the Udzungwa population (Jones *et al.*, 2005). In July 2004 TJ & RL had counted a total of 3 groups within an area of 3 km^2 in southern Ndundulu Forest. Surveys of an additional 4km^2 of surrounding forest had failed to produce any sightings of kipunji. Interviews with the local Wahehe people of the nearest village of Udekwa had revealed that the current human population in the Udzungwa Mountains (unlike at Mount Rungwe) were not familiar with kipunji. Surveys within the previous decade by myself and other researchers of neighbouring forest blocks indicated that kipunji were probably absent from large areas of potential habitat (see Appendix 1). However, it was clear that these animals were extremely shy and difficult to detect, and could therefore have been missed by some of these surveys, especially those of a broader nature not focused specifically on primates. Moreover, there still existed a large, relatively unexplored area of forest adjacent to the site of the discovered population which could potentially contain more groups. Thus we had estimated the geographic range of the population to be 3 to 50 km^2, and stated that the total population size was unlikely to exceed 500 animals.

The urgent next steps towards effective conservation planning involved research to better understand the conservation status of the population. This project was designed to achieve this goal through collection of the required information on distribution, abundance and threats to the population. The timeframe of the project (from applying for research permits through to completion of the fieldwork and data analysis) was from January 2005 until July 2006.

Specifically, <u>one primary and several secondary objectives</u> were identified for the project:

<u>Primary objective</u>

- ***To thoroughly survey the predicted maximum possible range of this endangered species in the Udzungwa Mountains, in order to determine overall distribution, estimate abundance and assess threats to the population.***

Secondary objectives

- To begin follows of a focal group to obtain preliminary information on important foodplants, seasonal ranging behaviour and inter-specific associations; to record vocalizations.
- To obtain faecal material for non-invasive molecular analysis of the population.
- To collect survey data on all other primates present. *Ad hoc* biodiversity data on other taxa to be collected, especially birds.
- To recruit and train a Tanzanian graduate assistant in technical field and conservation skills, and employ and train two other locally recruited fieldworkers.
- To raise local awareness through workshops in surrounding villages of the presence of this species and associated conservation issues.
- To generate recommendations for conservation of the Udzungwa population.
- To disseminate results and recommendations to all appropriate local and national authorities, NGOs, individuals and institutions; and to the IUCN for formal Red List species assessment.

All of the above objectives have either been fulfilled, or will be fulfilled following the dissemination of this report:

- 20 follows of focal group (i.e. on different days) completed by March 2006: 20 foodplants identified; ranging of focal group mapped (using hand-held Garmin GPS units); 4-6 distinct vocalisations identified and recorded (using Marantz PMD660 Solid State Recorder with Sennheiser K6-ME66 microphone combination); regular inter-specific associations noted; data collection and analysis ongoing, in collaboration with WCS Southern Highlands Conservation Programme
- Faecal material exported for molecular analysis
- Survey data for other faunal taxa to be entered into database and published
- Experienced graduate from University of Dar es Salaam (KA) recruited, field skills enhanced; several local fieldworkers recruited and trained
- Awareness-raising talks and workshops for local villages successfully carried out (Appendix 2)
- Dissemination of this report (english and/or swahili versions) to several stakeholders including:

    - Iringa Regional Administrative Secretary
    - Kilolo District Commissioner
    - Tanzania National Parks
    - Tanzania Forestry and Beekeeping Division
    - Ministry of Natural Resources and Tourism
    - World Wide Fund For Nature - Tanzania
    - International Union for the Conservation of Nature
    - Conservation International / Critical Ecosystem Partnership Fund
    - Fauna and Flora International
    - Wildlife Conservation Society

The remainder of this report focuses on the primary objective of the project: assessing the conservation status of the population.

Study area

The Udzungwa Mountains of south-central Tanzania ('Udzungwas': 10,000km^2, 300-2600m a.s.l.) are a mosaic of forest, miombo woodland, dry bush and grassland (Dinesen *et al*., 2001). Extremely biodiverse and rich in endemic and endangered species, they have in recent years become recognized as one of the most important areas for biodiversity conservation in East Africa (e.g. Burgess *et al*, in press; Myers *et al*., 2000). The discovery of kipunji brings the total number of primate species in the Udzungwas to 12, including 3 endemic or near-endemic monkeys (F. Rovero & A. Perkin, pers. comm.).

Kipunji were located in 2004 in the south of Ndundulu Forest (fig. 1). After reviewing existing literature and unpublished survey reports (see Appendix 1) and consulting with other researchers familiar with the Udzungwas, the potential range of the population (i.e. areas where kipunji may have gone undetected) was estimated, and formed the focus of this investigation. This area comprised three large forests: Ndundulu Forest, Luhomero Forest, and Nyumbanitu Forest.

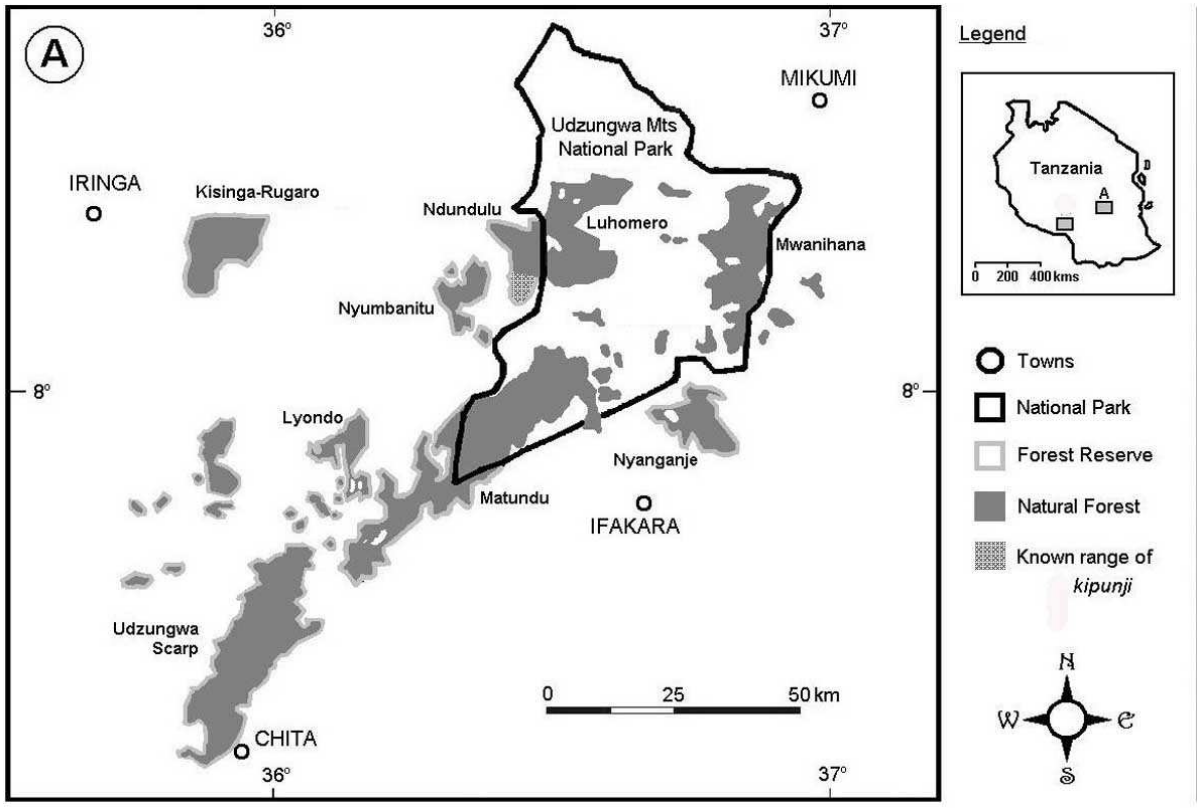

Fig. 1. Map of the major forests of the Udzungwa Mountains, showing site of discovery in 2004. Inset shows the locations of the two kipunji populations.

Ndundulu Forest

Ndundulu Forest (36°30'E, 7°45'S, 1300-2000m asl) is one of three forests (together with Nyumbanitu and Ukami) which together form the West Kilombero Scarp Catchment Forest Reserve (WKSCFR, 104,296ha), gazetted in 1957 under the jurisdiction of the Tanzania Forestry and Beekeeping Division (FBD). This Reserve originally contained the whole of the Ndundulu-Luhomero forest-covered massif. However in 1992, the Udzungwa Mountains National Park was gazetted, leaving only about one-quarter of this forest block within the WKSCFR (fig. 1). The forested area remaining outside of the UMNP is known as the Ndundulu Forest (with the contiguous area of forest inside the UMNP known as Luhomero Forest). In 2001, Ndundulu Forest became a Participatory Management Forest, under the terms of an agreement between the FBD and the villagers of Udekwa, which places management of the forest under the responsibility of the Village Government, and provisions for the accruement of revenue for the village from such forest usage as tourism and research (FBD, 2002). This management agreement will be reviewed by the Ministry of Natural Resources and Tourism in 2007.

Ndundulu Forest is one of the richest and most biodiverse of all forests in the Udzungwa Mountains and the entire Eastern Arc (Frontier Tanzania, 2001; Dinesen *et al*., 2001; Burgess *et al.*, in press). As an indication of its extraordinary richness across all taxa, Ndundulu is home to 22 restricted-range bird species (Marshall *et al.*, 2001; T. Jones, unpubl. data) and at least three restricted-range primate species (*R. kipunji*, Udzungwa red colobus *P. gordonorum*, and an undetermined species of bushbaby *Galagoides sp.*; A. Perkin, pers. comm.). The other diurnal forest monkeys present are Angolan black-and-white colobus *Colobus angolensis* and Sykes's monkey *Cercopithecus mitis.* In addition to kipunji, in recent years a new genus and species of bird (Dinesen *et al*., 1994), a new species of shrew (Stanley *et al*., 2005) and a possible new species of giant sengi (Rovero & Rathbun, in press) have been discovered in this forest.

The following list of common tree species is taken from Lovett & Pócs (1993), p.23, where they describe the montane forest vegetation of the West Kilombero Scarp Forest Reserve (applicable also to Luhomero forest within the UMNP). This category describes the forest type found from approximately 1300-2000m (above which the forest becomes 'Upper montane forest' *sensu* Lovett & Pócs), and thus covers the known range of kipunji.

Montane forest:
At higher altitudes trees include:
Afrocrania volkensii, Cassipourea gummiflua, Craibia brevicaudata, Maesa lanceolata, Neoboutonia macrocalyx, Polyscias fulva, Zanthoxylon gillettii.
At lower altitudes trees include:
Afrosersalisia cerasifera, Bequaertiodendron magalismontanum, Caloncoba welwitschii, Cleistanthus polystachyus, Cola greenwayi, Cylicomorpha parviflora, Drypetes usambarica, Myrianthus holstii, Ochna holstii, Parinari excelsa, Strombosia scheffleri, Trichilia dregeana.

Fig. 2. Ndundulu Forest

Methods

Field Methods

From October to November 2006 training in fieldwork skills were undertaken by the team, including practice detecting kipunji in the Vikongwa valley. All four members of the team (KA, RL, AM & TJ) already had at least two years' experience of surveying and observing primates in Tanzanian highland forests.

Data collection for the assessment of distribution and abundance was carried out in two phases. First, to determine distribution, we identified and ***surveyed*** eight key areas from which kipunji were already known, or where we suspected they may be present. Second, having mapped the distribution of the population based on the results of these surveys, we carried out a more intensive ***census*** of this entire focal area to estimate density and abundance. Methodologies for the two fieldwork phases differed, and are described below.

Phase I: <u>Survey</u>

Eight areas were identified as being of top priority for the survey, as shown in Fig. 4. Areas were decided with reference to satellite images and vegetation maps, and based on an evaluation of a combination of factors: our prior knowledge of the area; existing information from previous surveys (for more details, see Appendix 1); the habitat type and altitudinal range within which kipunji were so far known. Amount of effort at each site was allotted proportionally (Krebs, 1999), and was flexible in response to rapid evaluation of habitat suitability during the first days of surveying (White & Edwards, 2000). The first key area was the 'Vikongwa' area, which constituted an expansion of the $3km^2$ core area from which they were sighted in 2004. Thereafter, particular focus was given to the 'Pimbi' area, since we expected to find kipunji in Luhomero (within the Udzungwa Mountains National Park) and the 'Pimbi' area represents a vital corridor of potentially suitable habitat between Luhomero and their known site in Ndundulu. The eastern portion of Nyumbanitu was initially considered potentially important, but allotted survey effort was reduced because the relatively dry forest found there was judged to be unsuitable habitat.

Fig. 3. Typical survey expedition

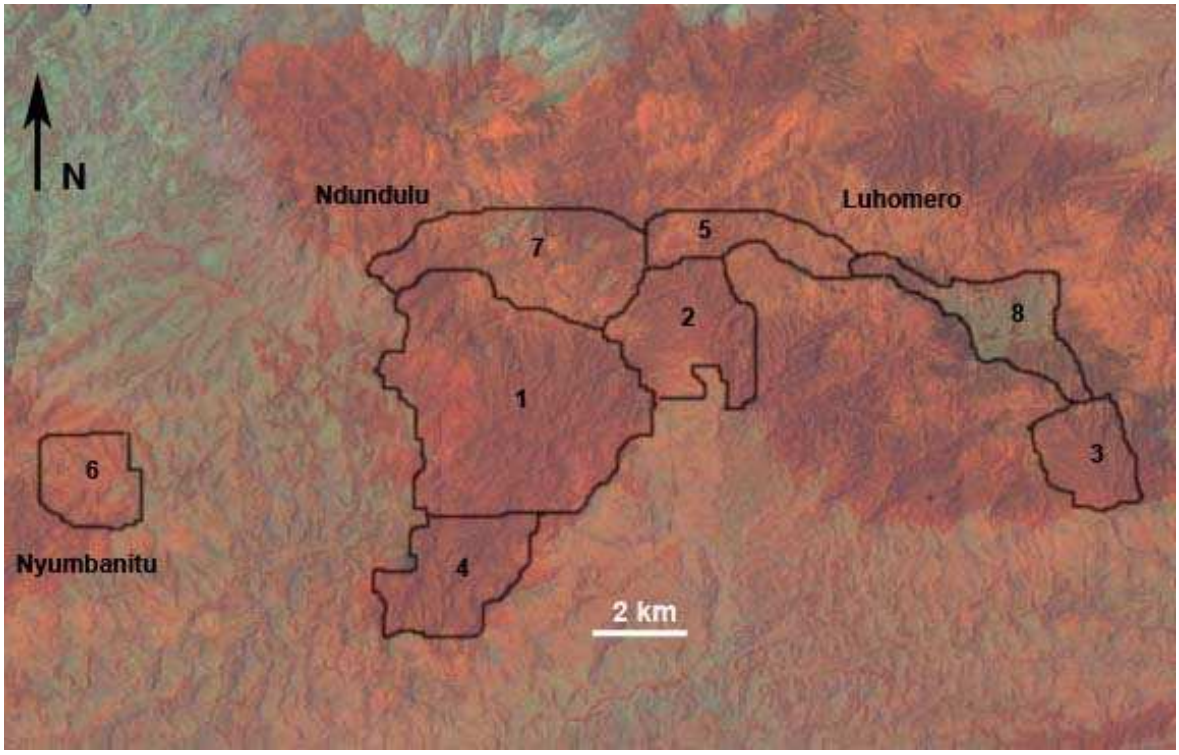

Fig. 4. Satellite map of eastern Nyumbanitu, Ndundulu and part of Luhomero forests (dark red = moist closed canopy forest) showing areas visited to survey for kipunji during this project, November 2005 – March 2006, in order of survey effort in each area.
Key: 1.Vikongwa; 2.Pimbi; 3.Blu; 4.Bundi; 5.Ruipa; 6.Nyumbanitu; 7.Luwala; 8.Luhomero
(See Appendix 1 for information on previous surveys of these and surrounding forests.)

At each site, at least 2 pairs of observers concurrently surveyed for kipunji along separate pre-planned routes using 1:50 000 topographic maps (Tanzania Surveys and Mapping Division, Series Y742, Sheets 216/4 & 217/3, Editions 1-TSD), compass, handheld GPS unit (Garmin Etrex) and binoculars. New areas were surveyed each day, adjacent to the area covered the previous day. However, some areas were selected to be revisited after some days, e.g. areas containing a high density of currently fruiting trees and other primate species. Survey routes were not linear but followed wildlife trails as much as possible, and were selected to strike a balance between surveying as large an area as possible, and attempting to survey each area thoroughly, considering the elusiveness of our target animals. An average day's survey route was along a loop starting and finishing at camp of approximately 5-7 km in length. Each observer-pair walked slowly and quietly scanning the understorey and canopy for monkeys, and listening for vocalisations. 1-2 km^2 were covered per hour, between 0650 and 1830 hours; surveying was generally paused between 1230 and 1430 hours, and whenever heavy rain occurred, as kipunji were observed to usually be inactive at these times. Whenever a monkey individual or group was detected, the observer remained until he was confident he had confirmed all of the primate species which were present. For all primates encountered, the following data were recorded: species, minimum group size, age and sex, and location (UTM co-ordinates). All primate vocalisations heard were also recorded.

A "survey-day" is defined as a minimum of 7 hours spent actively surveying by a single observer-pair in the course of a single day. Between 3.5 and 7 hours of active surveying on any given day (e.g. when rain halted surveying early) constituted 0.5 of a survey-day. Between November 2005 and March 2006, 50.5 survey-days were completed, within the survey areas shown in fig. 4. Survey effort at each site, together with the basic attributes of each survey site, are given in Table 1.

Table 1. Summary of areas surveyed and survey effort (excluding census) from November 2005 – March 2006.

Name of area surveyed[a]	Altitudinal range (m)	Co-ordinates of camp (UTM)	Survey-effort (days)	Area surveyed (km^2)
Blu	1390-2000	37M 236931 9136162	7.5	4.0
Bundi	1400-1790	37M 223016 9133819	7.5	6.0
Luhomero	2000-2500	37M 232767 9139394	2.0	5.1
Luwala	1800-2050	37M 224990 9141254	2.5	5.8
Nyumbanitu	1400-1800	37M 215372 9135680	3.0	4.0
Pimbi	1300-2000	37M 228408 9138901	9.5	5.5
Ruipa	1700-2000	37M 228391 9140710	3.5	4.4
Vikongwa	1300-1800	37M 224594 9136566	15.0	15.0
Total	**1300-2500**		**50.5**	49.8

[a] On the place names given to the areas surveyed: 'Ruipa' (river), 'Luwala' (open swampy valley) and 'Vikongwa' (river and valley) are existing local names for natural features within Ndundulu and Luhomero forests; 'Luhomero' was so called because the camp was close to the peak of this mountain (the highest point in the Udzungwas, at 2561m asl), while 'Nyumbanitu' is the only camp that we made in that forest. 'Blu', 'Bundi' and 'Pimbi' were arbitrarily invented by ourselves for the camp we established in each area.

Phase II: Census

After completing the survey work, we had only recorded kipunji within an area of approximately 7 km^2. We therefore conceived a more intensive census of this area with the aims of: 1) estimating density and abundance; and 2) obtaining an approximate encounter rate with kipunji across an area in which we already knew they were present, to guide design and analysis of future surveys.

We walked in pairs slowly and quietly searching for kipunji, between 0650 and 1830 hrs, and we paused work between 1230h and 1430 h each day, and whenever there was hard rain. Data collection upon encountering primates followed the same protocol as the surveys.

For the census, we followed pre-planned linear 'reconnaissance transects' (e.g. Hall *et al*., 1998; Walsh & White, 1999). That is to say, each observer-pair roughly followed the same direction using compass and GPS (as much as the steep forested terrain would allow), but when necessary took the 'path of least resistance' rather than cutting through thick understorey. Whenever a monkey was

detected, the observer left the transect in order to observe it, then returned to the transect line and continued along the same compass line.

The census was designed to systematically cover an area of approximately 11 km^2 (see fig. 5), and took place over 7 days. Each day, 3 observer-pairs walked roughly parallel transects which were 100-300m apart, in order to minimise double-counting of a single kipunji group. Observers checked on each others' positions at pre-arranged times every 2-4 hours using walkie-talkie radios (Cobra Microtalk, USA). The next day, the observers shifted to an adjacent area. No areas were visited more than once.

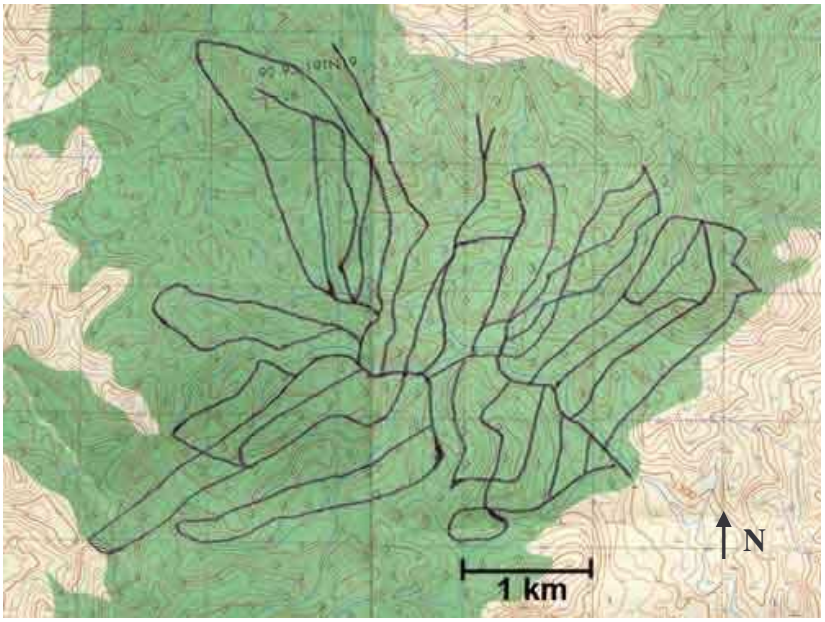

Fig. 5. Routes walked during 7-day kipunji census, March 2006, Ndundulu Forest.

Village Interviews

Interviews conducted by TJ in 2004 with 6 people from the nearest village of Udekwa, including 2 of the oldest hunters in the village, had suggested that there was no local knowledge of kipunji (Jones *et al*., 2005). To confirm this, 12 further semi-structured interviews were conducted in the village. In addition, as part of the environmental education activities we initiated (see Appendix 1), discussions were held at large public meetings in Udekwa with a total of over 200 members of the local community. At each of these meetings, the people present were asked whether they had any prior knowledge of kipunji.

Other data collected

During both phases of the fieldwork we opportunistically recorded all signs of human disturbance encountered, including: fresh and old signs of cutting; human trails; snares and other traps; other signs e.g. remains of hunters' camps.

We also recorded all primates and other identifiable mammals encountered, including dung and other sign of large mammals especially elephant, leopard, the endangered Abbott's duiker *Cephalophus spadix* and other forest antelopes. In addition, records were made of all sightings of the endangered Udzungwa forest-partridge *Xenoperdix udzungwensis* (all observers) and other birds (TJ only).

During the course of this project we collaborated with Dr. Francesco Rovero (Trento Museum of Natural Sciences, Italy) and Dr. Galen Rathbun (California Academy of Sciences, USA) on a study of giant sengis in Ndundulu; our census results for this taxon are to be included in a forthcoming scientific publication lead-authored by Dr. Rovero.

Mapping of results

All kipunji sightings from the survey and census, together with all previous and subsequent sightings from November 2004 up to the end of August 2006 were entered into ArcMap 8.1 (ESRI, Inc, 1999-2001). The area of known distribution was calculated by drawing a polygon around all the definite sightings, and simply measuring its area. This area was not adjusted to account for topography, and thus corresponds to a 2D layer on a map and not actual home range on the ground. In this case, since the area in question is comprised almost entirely of steep hills and valleys, the actual home range may be up to 50% greater than the area of the polygon. It is hoped in the future to develop a reasonably accurate means of converting from one estimate to the other.

GPS coordinates taken during the 7-day census were plotted (fig. 5) in order to estimate the total length walked. Thus this estimated distance also corresponds to a 2D layer on a map.

Results

Distribution

In the course of 50.5 survey-days from November 2005 to March 2006, kipunji were definitely encountered on 5 occasions. All of these encounters occurred in the Vikongwa valley of Ndundulu Forest. A possible sixth encounter occurred in the Bundi area in Southern Ndundulu, but this was not confirmed and is thus discounted[1].

The current known distribution of the Udzungwa kipunji population was calculated at 7.24 km^2 of Ndundulu Forest.

Kipunji are not currently known from within the Udzungwa Mountains National Park; the closest current record is of a group 1.89 km outside of the Park boundary.

Density and Abundance Estimates

In the course of the intensive census in the Vikongwa Valley of Ndundulu Forest, observers walked an estimated total distance of 61.3 km during 132.5 census-hours over 7 days. Kipunji groups were encountered on 3 occasions, giving encounter rates of 0.05 groups encountered per kilometre walked, or 0.023 groups encountered per hour.

On the basis of the survey results, census results, and all other encounters with kipunji from November 2004 to August 2006 (n=31), it is estimated that the Ndundulu population comprises 3-6 groups.

To estimate abundance I have made use of the few reliable counts of individuals per group recorded to date, divided into: a) "complete" group size counts, where the observer was certain that all animals were counted; and b) "almost complete" counts, where the observer was >95% certain he saw all the animals present, therefore we are confident that either all or the great majority of individuals were counted. Almost complete group size counts have been as follows: 15; 20; 25. One complete count was made of 15 individuals. (Several minimum counts ranging from 9-15 have also been made). Known group size thus varies between 15 and 25, allowing a crude estimate of mean group size as 20. Using the minimum number of groups and this mean group size, we can reach a conservative lowest estimate of abundance thus: 3 groups x 20 individuals = 60 individuals. A highest estimate can be made using the maximum estimated number of groups and the maximum recorded group size: 6 groups x 25 individuals = 150 individuals. Combining these lowest and highest estimates gives us an estimated range for total abundance of the population:
60 - 150 individuals.

[1]On the final day of surveying this area, some monkeys were heard moving in the canopy. Their near-silent fleeing behaviour suggested kipunji, however they were not seen and attempts to locate them again failed, thus this possible record could not be confirmed.

Local Knowledge

During all of the interviews and public meetings conducted, involving in total more than 200 adults of the local community, nobody betrayed any prior knowledge of the presence of kipunji in Ndundulu Forest. This included several people with a good knowledge of the other large mammals present in the forest.

Threats to population

All of the areas surveyed in Ndundulu and Luhomero (and the relatively small part of Nyumbanitu visited) are these days remote from human settlements and activity. Nearly all of the forest visited in central and southern Ndundulu and Luhomero is in excellent condition, with very little or no sign of any recent activity (see also Dinesen & Lehmberg, 1996; Topp-Jørgensen *et al*., 2001). The forest is primary with little evidence of past cutting, and no instances of recently cut trees were recorded in these areas. No pitsawing sites (recent or old) were found, nor were any snares found. On Luhomero there was some scant evidence of recent presence of people (signs of a camp from 2004), and there were reports of occasional hunters still moving through the area hunting elephant and buffalo.

Most importantly however, the area of Ndundulu still containing kipunji is pristine mature primary forest, and in the time we have been working there since 2004, we have not observed any signs of human activity in the area. There appear to be no current anthropogenic threats to the Udzungwa kipunji population.

Ndundulu Forest as a whole however is affected by regular bushfires deliberately lit outside but close to the forest from June to November each year.

Discussion

Surveying and monitoring kipunji in the Udzungwas

Locating and counting kipunji in Ndundulu is particularly challenging compared to most other diurnal forest monkeys, for a number of reasons. First, they are at very low density. To compare with the other monkeys of Ndundulu, over the entire census (61.23 km walked) we recorded 29 encounters with Angolan black-and-white colobus at an encounter rate of 0.47 groups per km walked, 27 encounters with Udzungwa red colobus at a rate of 0.44 groups per km, and 20 encounters with Sykes's monkeys at a rate of 0.33 groups per km. In contrast, kipunji were encountered 3 times, at a rate of 0.05 groups per km.

Second, though kipunji have occasionally been seen to come to the ground to feed, they consistently travel and flee through the mid-upper canopy. In the Vikongwa Valley, this canopy is closed and usually 40-50m high, restricting visibility. Third, they are extremely vigilant, shy and quiet monkeys, vocalising infrequently and without a loud-call to compare with other *Papio* or *Lophocebus* species (Waser, 1982; Jones *et al.*, 2005). They are frightened of people and upon detecting human presence they either move away out of sight, or hide in the upper canopy for up to two hours. Fourth, there are difficulties with determining group size because we do not yet understand the social system of this population. Typically, whenever a group is encountered it nearly always splits into two or three 'sub-groups' in response to our presence, usually – though not always – reforming into one large group one to three hours later. Whether this is a particular strategy in response to humans, or whether it is indicative of a generally fluid ('fusion-fission') grouping system as found in some other primate species (Lehmann & Boesch, 2004), will have to be determined through long-term research.

In spite of these challenges it is important that a) further surveying is carried out in areas not covered during this project (e.g. parts of southern and eastern Luhomero); and that b) long-term monitoring of the population is initiated. Therefore the efficacy of different survey and census methods is a critical issue. For surveying new areas, where the primary aim is simply to determine the presence or absence of kipunji, the survey method described here strikes a good balance, given the inevitable constraints of limited resources (time, money, experienced observers), between attempting to not miss any groups and covering relatively large and remote areas of forest of demanding terrain. Moreover the results of the census, which retained the same protocol for trying to spot the monkeys as during the broader survey, showed that this method works for locating kipunji. It is however possible that a playback method for locating groups, as deployed successfully on some other primate species (e.g. Whittaker, 2005) may be useful in reducing survey time. Although preliminary playback trials on kipunji in the Southern Highlands were so far not very effective (T. Davenport, pers. comm.), trials should be attempted on the Ndundulu population as soon as possible.

Among the several methods which have been described for monitoring tropical forest monkey populations, the line transect method has become one of the most widely used (Struhsaker 1981, 2002). However, analysis of line transects for estimating density (usually done using the software DISTANCE) requires a minimum sample size of 60-80 sightings (Buckland *et al.*, 1993). The extremely low kipunji encounter rate obtained during the census (0.05 groups per km) suggests that line transects would be impractical for monitoring this population.

The census method deployed here using reconnaissance transects 100-300 m apart is effectively an adaptation of the sweep census method, in which several observers move through an area along parallel transects attempting to provide complete coverage of an area (Struhsaker, 2002). In a sweep census however it is assumed that a total count of all individuals of the target population is achieved. In the case of the kipunji census, I describe the method as adapted because this assumption could not be confidently met. Because of the terrain and low visibility of Ndundulu Forest, and the extremely secretive behaviour of kipunji, in particular their ability to hide in the canopy overhead, a true sweep census meeting the assumption of a total count is probably impossible with this species. Moreover, to attempt such a census with the resources available would have meant covering only a small fraction of the known distribution of the population (and may well therefore have resulted in no sightings at all). Given their extremely low density, it was important to cover the whole area from which kipunji were known, thus the more practical method described was employed. Of course, the disadvantage is that possibly not all of the groups present were detected. This possibility combined with a review of all the sightings to date informed the total estimate of 3-6 groups in the population.

As with presence/absence surveys, a playback method has the potential to assist with long-term monitoring of the kipunji population, and experiments should be carried out to test this possibility on the Ndundulu population. Ultimately however, since the population is so small, it should be possible to monitor the population in the long-term through regular counts of all the groups after they have been semi-habituated. This is the most accurate method for estimating density and total abundance (Struhsaker, 2002), and has several further advantages including: scouts from the local community can be trained to carry out this work, enhancing awareness and a sense of local 'ownership' of the forest; increased protection for the monkeys; facilitation of vitally needed long-term ecological research on these monkeys.

A critically endangered population

The results of this project show that the kipunji population in the Udzungwa Mountains is critically endangered, yet the reasons for this are currently unclear. Our surveys confirmed on the one hand that there are probably no more than 150 animals, while on the other hand they have not been subject to any hunting pressure in recent years, and there is no indication that any anthropogenic disturbance to their core area is imminent. The greatest threat to this population may be that it is now too small to be viable in the long-term (Harcourt, 2002).

The Ndundulu kipunji population is one of only two populations of this newly-discovered genus and species. In the Southern Highlands, the population is higher but still very low. A full census and ecological analysis have just been completed there and the results will be published soon (T. Davenport, pers. comm.). In any case, the Udzungwa population has been isolated for several million years and is of extremely high conservation importance in its own right. In order to conserve it, we must attentively monitor the health of the population while urgently seeking to understand what has caused it to reach such critically low numbers.

It seems certain that this population was once much larger and formerly occupied a greater range, probably including large areas of Luhomero Forest, which contains very similar habitat and is contiguous with the currently occupied range. Habitat loss cannot explain this change, though subtle changes in the plant community caused by long-term climate change (perhaps resulting in loss of key resources) is an arguably plausible theory (which will be very difficult to prove). Disease,

predation, or resource competition with other primates, might have led to the extirpation of kipunji from its former range. These theories seem unlikely however, as there are no documented cases of similar processes occurring on this scale in other parts of Africa. Perhaps the most likely explanation is that kipunji has been hunted out of its former range by humans – something that has happened to several monkey populations across equatorial Africa in recent decades (e.g. Oates *et al*., 2000), including in the Udzungwa Mountains (Rodgers & Homewood, 1982). Kipunji are still hunted today in the Southern Highlands (Davenport & Jones, 2005). However if this occurred historically in the Udzungwas, the population must have been hunted to near-extinction prior to at least thirty years ago, otherwise one of the old hunters we interviewed in Udekwa would have remembered kipunji.

Fig. 6. Section of 1:500 000 map of villages from 1977 ('Mkoa Wa Iringa'; Surveys and Mapping Division), with approximate area of Ndundulu-Luhomero forest shaded. The villages of Luwala, Ikamba, Ndene, Kisada, Masenga, Lofia, Lohomero, Mlale and Kimenya are within the current boundary of the Udzungwa Mountains National Park, and therefore no longer exist.

A map of villages in the local area from 1977 (fig. 6) shows that there used to be at least 10 villages in the vicinity of Ndundulu and Luhomero, probably constituting at least 20,000 people. Most of these people had been evicted from the area by the time of the gazettement of the Udzungwa Mountains National Park in 1992. All of these villages would have been comprised entirely of people of the Wahehe tribe, who traditionally hunted all types of monkey for food – and still do today in some areas of the Udzungwas (personal observations; Moyer & Mulungu, 2004). This potential pressure lends weight to the artefact-of-hunting theory for the decline of the kipunji population, especially if for some reason they are more vulnerable (or were more desirable) to the hunter than the other monkey species present.

A further question - of greater contemporary importance - is this: following the hypothesised decline of the kipunji population, why, assuming that they have been under no anthropogenic pressure for several decades, have they not 'bounced back' and increased in number, and re-colonised parts of their former range?

There may be a complex suite of factors now preventing the population from increasing, such as resource competition or predation, whose effects may be exacerbated by ecological and behavioural changes caused by the decline of the population to such a drastically low number of individuals.

Behaviourally, the shyness of the population might be considered extreme compared to other forest monkeys, and as already mentioned it appears that the social group may not be very cohesive. Another indication of a kind of ecological collapse may be group size, which is significantly smaller than found in the larger and more widely distributed Southern Highlands population (group size estimates from 15-25 in Ndundulu compared with 30-36 in the Southern Highlands; Davenport *et al.*, 2006).

For now, these ideas are nothing more than hypotheses, but what seems certain is that the population is vulnerable to extinction, and therefore deserving of our conservation attention to ensure that it survives. For the long-term, the villagers living in adjacent areas should continue to be involved in monitoring the kipunji population, and there is also need for more intensive specialist ecological research into the causes of the population's low abundance.

Key to the kipunji's survival will be the total protection of their forest habitat, which was already known to have exceptional values of biodiversity and endemism. The south of Ndundulu Forest is currently pristine and undisturbed, but in the north there is secondary forest caused by past logging (Topp-Jørgensen *et al*., 2001), and an overflight of the area in 2005 revealed that farms have recently spread to the very edge of the northern boundary of the forest, and that some encroachment is occurring. Another important issue to be tackled is the setting of bushfires in the dry valleys along the northern and western boundaries of Ndundulu Forest, which every year sweep to the edge of the forest and even enter the forest, degrading the habitat along the forest edge and preventing the forest from regenerating into the valleys (Frontier Tanzania 2001; pers. obs.). There is a case for creating a firebreak around the forest, though the ecological impact of such an intervention should be studied carefully before proceeding.

Currently Ndundulu Forest is under Participatory Forest Management, under an agreement between the communities of Udekwa and Ifuwa, and the Forestry and Beekeeping Division (FBD). Vital support for the local communities and protection of the forest is also currently provided by Tanzania National Parks (TANAPA) and the World Wide Fund for Nature. This management arrangement will continue until 2007, after which the status of Ndundulu Forest will be reviewed by the Ministry of Natural Resources and Tourism. There are contrasting proposals currently under discussion to either make the forest part of a large Nature Reserve under the management of the FBD, or to annex Ndundulu Forest into the Udzungwa Mountains National Park, to bring it under the management of TANAPA. Whichever option is decided upon, it is critically important that the necessary resources are secured for the effective long-term protection of the whole forest.

Kipunji as a flagship species

A key component of any long-term conservation programme is the raising of awareness among local communities on environmental issues, the value of biodiversity, and wise stewardship of the local natural resources on which their livelihoods depend.

The concept of a flagship species to highlight the biological values of a site can be an extremely useful one, both in an environmental education programme and in attracting resources for wider conservation activities for the area. A flagship species should be an endangered charismatic animal whose conservation will have a significant knock-on effect of enhanced conservation for many other endangered species dependent on the same habitat (Mickleburgh, 2002).

Kipunji fits the bill perfectly as a flagship species - or in this case flagship genus! – for Ndundulu Forest and the other surrounding forests (Luhomero, Nyumbanitu and Ukami) which are so extraordinarily rich in endangered and endemic species. It is a large charismatic monkey that is in real trouble, for poorly understood reasons. Moreover, its recent discovery and subsequent taxonomic upgrading from new species to new genus have generated large amounts of publicity in both national and international media. Thus it is already famous amongst the national and international scientific, conservation and donor communities, and beyond. This presents an opportunity to utilise the fame and recognised importance and status of this taxon to attract funding and work on the long-term conservation of these forests. This opportunity has been recognised in the Southern Highlands, where kipunji is being used as a flagship for the forests there (T. Davenport, pers. comm.).

As part of this project we began the process of using kipunji at the centre of a local environmental educational programme. For example a "Kipunji Day" held in the village of Udekwa involving talks, films, discussions and fun activities (for both adults and children separately) proved highly successful, with many requests received from the village to repeat it (see Appendix 2). Our experiences suggest that there is much scope for further activities of this kind in the local area.

Summary of Recommendations

- Increased training to build capacity for a long-term community-based monitoring programme
- Further surveys of remote areas
- Testing of playback surveying and censusing methodologies
- Intensive ecological research into the reasons for the critically low population size
- Continued local community conservation activities
- Continued awareness-raising of local forest biodiversity values utilising kipunji as flagship species
- Ecological feasibility study on creating a firebreak around Ndundulu Forest
- Resolution of long-term status of Ndundulu Forest under management regime with the necessary resources for sustainable protection of the whole forest

Ongoing work

In collaboration with the Wildlife Conservation Society (WCS) we are initiating long-term research and monitoring of the kipunji of Ndundulu to complement the work being carried out on Mt. Rungwe and Kitulo. Currently, a small team of fieldworkers, including 3 trained staff from the village of Udekwa, are spending 20 days per month within Ndundulu Forest tracking and observing a focal group. Our priority aims for the future, in keeping with the recommendations discussed above, are as follows:

- Development and testing of more efficient and accurate censusing methodology for this population, including trial of playback methods
- Further surveys of remote areas of forest for the presence of kipunji
- Study of demography and recruitment in the population
- Ecological research into potential factors constraining population size: habitat suitability and use; predation; interspecific resource competition
- Taxonomic study involving comparative phylogenetic and morphological analyses, and comparisons of vocalisations and ecology, between the two kipunji populations
- Continued promotion of the critically endangered kipunji as a flagship species for the Northern Udzungwa Mountains, highlighting the biological and water catchment values of the entire Luhomero-Ndundulu massif
- Establishment of a long-term community-based monitoring programme

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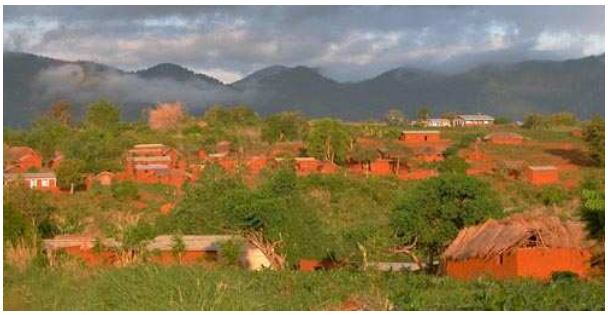
Appendix 1. Supporting evidence on the distribution and abundance of kipunji

The following table summarises previous zoological surveys carried out in Ndundulu, Luhomero, Nyumbanitu and Ukami (plus information from interviews with hunters). Additions to this list will be gratefully received. N.B. "colobines" = Udzungwa red colobus and Angolan black-and-white colobus.

Site	Year(s) of survey	Approx. survey effort (days)	Target species	Kipunji recorded	Notes	Source
Northern and Southern Ndundulu	1999-2000	20	Primates	No	20 repetitions of 2 line transects; colobines and Sykes's recorded	Marshall *et al*., 2001, 2005; A. Marshall *pers. comm.*
Northern Luhomero	2002	24	Primates	No	Survey methodology similar to kipunji survey described in this report	Jones unpubl. data (May 2002 survey with T. Butynski, C. Ehardt); Jones & Rovero 2002
Luhomero	1998	6	Primates	No	Rapid recce surveys; colobines and Sykes's recorded	Ehardt *et al*., 1999
Nyumbanitu	1992, 1993, 1994, 2002-3	123	Birds	No	>100 encounters with colobines and Sykes's monkeys recorded	Louis Hansen *in litt.*; Dinesen *et al.*, 2001
Southern and central Ndundulu	1991-1992	379	Birds	Yes	Kipunji (misidentified as Sanje mangabey) encountered 5-6 times within known range but not around Mofu base camp, 1km away	Lars Dinesen *pers. comm.*; Louis Hansen *in litt*.; Dinesen *et al.*, 2001
Ukami	1994	73	Birds	No	Colobines and Sykes's recorded	Louis Hansen *in litt.*; Dinesen *et al.*, 2001
Ukami	2005	2	Primates	No	Colobines and Sykes's recorded	F. Rovero *pers. comm.*
Ndundulu/ Nyumbanitu/ Luhomero	~1950-present	?	-	No	Good knowledge of the Ndundulu-Luhomero massif and Nyumbanitu, especially northern Ndundulu and Nyumbanitu; no prior knowledge of kipunji	Interviews with Mr. Janus Mudanga and other old hunters from Udekwa

Appendix 2: Raising awareness of <u>flagship species</u>

1ST "KIPUNJI DAY", UDEKWA VILLAGE, 2ND APRIL 2006



Udekwa village with Ndundulu forest in the background

Showing environmental films in the village hall

Explaining kipunji monitoring and research...

...followed by football: village team vs researchers