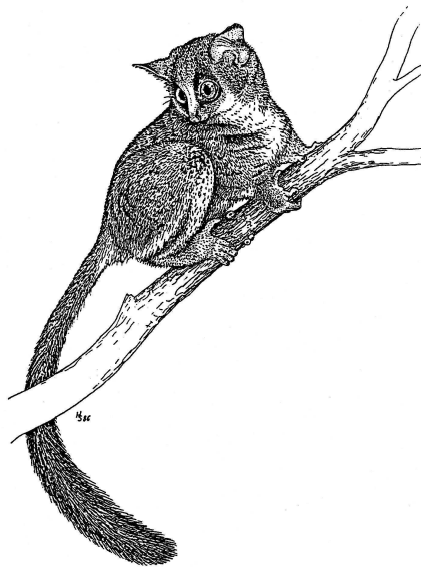


Wildlife Conservation Society of Tanzania (WCST)

For the Uluguru Mountain Biodiversity Conservation Project (UMBCP), a collaboration between the Wildlife Conservation Society of Tanzania (WCST), the Uluguru Mountains Agriculture Development Project (UMADEP), the Regional Natural Resources Office (RNRO) and the Regional Catchment Forest Project (RCFP).

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The Taxonomic Status and Distribution of Bushbabies (Primates, Galagidae) in the Uluguru Mountains

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The Taxonomic Status and Distribution of Bushbabies (Galagos) in The Uluguru Mountains

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The Taxonomic Status and Distribution of Bushbabies (Galagos) in The Uluguru Mountains

1. SUMMARY

The consultant was asked to collate information on the Galagos (Bushbabies) in the forests of the Uluguru Mountains. Three galago species are known to occur in the Uluguru Mountain forests, the Mountain galago *Galagoides orinus*, the Matundu galago *G. udzungwensis* and the Small Eared Greater Galago or Garnett's galago *Otolemur garnetti*. Of these, the Mountain galago *G. orinus*, an Eastern Arc endemic species, is of particular interest because the type locality for this species is located near Bagilo village close to Uluguru North Forest Reserve. A brief taxonomic review and history of research on this species is presented. New developments in species recognition methods are outlined and were employed in the fieldwork. The results indicate that only *G. orinus* occurs in Uluguru North and South Forest Reserves. This is a very significant population for the conservation of this species with more than 23,000 individuals estimated to occur. The data support the taxonomic status *G. orinus* as a valid species. Two other galago species *O. garnetti* and *G. udzungwensis* were found to occur in the lowland forests surrounding the Uluguru Mountains. Maintenance of forest habitat, even secondary habitat, will ensure these species survival in the Uluguru Mountains. Of notable conservation importance is Mkungwe Forest Reserve which contains the largest area of good sub-montane forest outside the Uluguru Mountains.

2. AIMS

The aims of this research project were to undertake the following tasks:

1. To provide information on the species of Galagos (Bushbaby) occurring in forests of the Uluguru mountains, in particular to determine the specific status of the dwarf Galago occurring in the montane forest areas. The field work was to be conducted at the following sites; the lowland forest of Kimboza Forest Reserve (FR) and in the montane forests of Uluguru North FR, especially in the area around Tegetero and Bagilo, and in Uluguru South FR.
2. To write up the results of these investigations as a short report to the UMBCP, summarising:
 - a. the history of Galago research in the Ulugurus Mountains.
 - b. the taxonomic status of the species of Galago in the Uluguru mountains.
 - c. the results of the current field investigation.
 - d. any recommendations which can be made with regard to the conservation of the Galago species in the Uluguru mountains.

3. BACKGROUND

Galago taxonomy

To understand the basis and relevance for this study in the Ulugurus it is necessary to provide some background to galago taxonomy that is now undergoing some radical changes due the way we now recognise this group of primates. Galagos, or bushbabies as they are sometimes known, occur only in Africa. They are nocturnal cryptic species, which makes identifying them in the field from morphological characteristics difficult. Recent research indicates that the number of 'species' may be underestimated when the differences in vocalizations, reproductive anatomy and genetics are considered. Traditional treatments on galago taxonomy have been based on long-established techniques of measuring relative anatomy largely based on museum collections (Table 1.).

When closer attention was paid to the study of galagos in the wild, it became clear that anatomical differences alone could not explain the diversity of cryptomorphic galago forms. Populations that were apparently anatomically very similar were noted to be diverse in terms of vocalizations, behavior and habitat use (Courtney and Bearder 1989, Nash *et al.* 1989). Galagos have been found to have very sensitive black and white vision and olfactory senses. Galagos therefore have not evolved colorful pelages such as the daytime monkeys or noticeable sexual dimorphism because they do not need them, but instead rely on olfactory and vocal communication (Bearder *et al.* 1995). Thus isolated populations may develop divergent vocal

and olfactory ‘repertoires’ that may ultimately become a barrier to successful breeding between the populations. For this reason, and for practical reasons, the current study initially identifies galago populations in the field primarily on the basis of identifying their calls and noting behavioral differences. These data are then compared with morphometric and genetic analyses.

Table 1 The progression of galago taxonomy at the species level by various authors this century.

Genus/ Author	Schwarz (1931)	Hill (1953)	Napier and Napier (1967)	Groves (1974)	Olsen (1979)	Fleagle (1988)
<i>Otolemur</i>					<i>crassicaudatus garnetti</i>	<i>crassicaudatus garnetti</i>
<i>Euoticus</i>	<i>elegantulus</i>	<i>elegantulus inustus</i>		<i>elegantulus</i>		<i>elegantulus matshei</i>
<i>Galago</i>	<i>crassicaudatus senegalensis alleni demidovii</i>	<i>crassicaudatus senegalensis alleni</i>	<i>crassicaudatus senegalensis alleni elegantulus inustus demidovii</i>	<i>crassicaudatus senegalensis zanzibaricus inustus alleni demidovii</i>	<i>senegalensis gallarum moholi elegantulus matshei</i>	<i>senegalensis gallarum moholi</i>
<i>Galagoides</i>					<i>demidoff thomasi zanzibaricus alleni</i>	<i>demidoff thomasi zanzibaricus alleni</i>
No. Species	5	6	6	7	11	11

The most recent study (Honest and Bearder, 1996) using these new methods resulted in several changes in galago classification within the genus *Galagoides* that affect Tanzanian and East African ‘dwarf galago’ species (see Table 2).

Table 2 Recent changes in the number of species recognised in the genus *Galagoides* in Tanzania.

Previous species name	After Honest and Bearder (1996)	After Kingdon (1997)
<i>Galagoides demidoff orinus</i> (Olsen, 1979)	<i>Galagoides orinus</i>	<i>Galagoides</i> species nova? <i>orinus?</i>
<i>Galagoides demidoff</i> *	<i>Galagoides rondoensis</i> <i>Galagoides udzungwensis</i>	<i>Galagoides rondoensis</i> <i>Galagoides udzungwensis</i>
<i>Galagoides zanzibaricus grant</i> (Olsen, 1979)	<i>Galagoides granti</i>	<i>Galagoides grant</i>

* The *Galagoides* specimens collected at the Rondo plateau (Hayman in litt) in south Tanzania in the 1950’s that were named as *Galagoides demidovii* (also renamed as *Galagoides demidovii orinus* by Jenkins, 1987).

A historical study of the Galagos on the Ulugurus.

Historically the sub-montane forests of the Uluguru Mountains are an important location for Galago research in Africa. They are the type locality of the rare Mountain galago *Galagoides orinus*. The lowland forests of the Uluguru Mountains are known to contain two other species of galago, the Matundu galago *Galagoides udzungwensis* and the Small Eared Greater Galago or Garnett's galago *Otolemur garnetti*.

The taxonomic status of the Mountain Galago *Galagoides orinus*.

The Mountain galago was originally described by Lawrence and Washburn (1936) as *Galagoides demidovii orinus*, a subspecies of Demidoff's galago *G. demidovii* which occurs in the West African and Congolese rainforest ecosystems. The common name 'Mountain galago' was first given by Olsen (1979) who conducted the most recent taxonomic review of Galagos. This description was based on a single specimen shot in forest close to Bagilo village (6°55'S 37°40'E) by Loveridge on the 17th September 1926 (also called Bagiro in the local language, Kiluguru). Further details of the capture and some discussion regarding the identity of the specimen, is given by Kingdon (1971). Due to this animal's small size and distinctive pelage, the specimen was placed in the genus *Galagoides* (Smith 1833), and was assigned to *G. demidoff* on the basis of cranial morphology. However, limited biometric information is available (see table 1.) in the type description. Honess (1996) provides further details on the taxonomic history of this species as well as the other Tanzanian galagos.

Recent research (Honess and Bearder, 1996) resulted in the elevation of the animal from the subspecies, *G. d. orinus* to the full species, *G. orinus*, largely on the basis of differences in the vocalizations of each form. The homologous call of Demidoff's galago has a distinct and 'a highly complex crescendo structure' (Bearder *et al.* 1995, Zimmerman 1990) as opposed to the calls of the Mountain form described by Honess and Bearder (1996) as 'simple Descending Whistle'. The vocalization data collected for their analysis was almost fully based on data tape-recorded at Amani in the East Usambaras Mountains. These vocalizations were compared with heard but non-tape recorded data from a short night survey in Uluguru North Forest Reserve near Bagilo (Honess 1996). Therefore, the population of dwarf galagos from Amani was identified as *G. orinus* on the basis of vocalization patterns before the full vocalization repertoire was known from the type locality population of *G. orinus* in the forests close to Bagilo in the Uluguru North Forest Reserve.

Further galago research in the Ulugurus since the original type description of *G. orinus*

Since the type description of *G. orinus* (Honess and Bearder, 1996), no further research on this species has been carried out in Uluguru North FR. No research on galagos has ever been carried out in Uluguru South FR. Honess (Honess 1996) made a brief visit to Kimboza FR and found *O. garnetti* and *G. udzungwensis* to occur there. No further confirmed specimens of *G. orinus* have been collected since the type specimen, although two animals shot by Jon Fjeldså (pers comm.) in the Udzungwa Mountains are likely to be of this form. A 1998 study (Butynski *et al.* 1998) found *G. orinus* to occur in the Udzungwa Mountains above 1000m asl. in sub-montane forest. It has been suggested that the species is endemic to the Eastern Arc Mountains (Honess 1996).

Other galago species known to occur in the Uluguru Mountains.

The small eared greater or Garnett's galago *Otolemur garnetti*.

This species is known to have a wide distribution in the coastal forests of eastern Africa, the Eastern Arc mountains, several inland volcanic mountains such as Kilimanjaro and the Kenya highlands and extends down into the Livingstone Mountains and northern Malawi (Jenkins 1987, Nash *et al.* 1989, and Kingdon 1997). *O. garnetti* is known to adapt to a wide variety of habitats from montane to sub-montane to lowland forests as well as plantations. However, *O. garnetti* does seem to be restricted to evergreen vegetation types and occurs sympatrically with the Large Eared Greater Galago *O. crassicaudatus*, which has a wide distribution in the drier miombo and *Acacia* woodland habitat of east and southern Africa (Kingdon 1997). In the Uluguru Mountains *O. garnetti* has been recorded in Kimboza forest reserve as well as in some peri-urban gardens in Morogoro town (pers. obs., Honess, 1996). Honess (1996) did not record this species in the Uluguru North FR (near Tegetero Mission at around 1000m asl.).

The Matundu galago *Galagoides udzungwensis*.

G. udzungwensis is only recently described (Honess and Bearder, 1997), and is known to occur in the lowland moist forests of the Udzungwa Mountains, and the East Usambaras mountains. This species has also been recorded in the coastal forests of Unguja island (Zanzibar), Pugu-Kazimzumbwe, Zarininge and Msumbugwe FR (pers. obs., Perkin 1999). In the Uluguru mountains this species has been recorded from Kimboza FR (Honess, 1996) and by the author during a brief opportunistic visit to Kimboza FR in October, 1999. This species has a distinctive advertising call and occurs sympatrically with the similar looking, Grant's galago *Galagoides granti* (Thomas and Wroughton 1907), which occurs south of the Rufiji river in coastal forest into Mozambique. Some question marks have however been raised about the taxonomic validity of *G. udzungwensis* since this species has been found to be very similar in terms of vocalizations and morphology, to the Zanzibar galago *G. zanzibaricus* (Perkin, 1999).

4. THE FIELDWORK REPORT.

Aim

To provide information on the species of Galagos (Bushbaby) occurring in forests of the Uluguru mountains, in particular to determine the specific status of the dwarf Galago occurring in the montane forest areas. The field work was aimed to be conducted at the following sites; the lowland forest of Kimboza Forest Reserve (FR) and in the montane forests of Uluguru North FR, especially in the area around Tegetero and Bagilo, and in Uluguru South FR.

Study sites

Two study sites in Uluguru North and Uluguru South Forest Reserves were visited during the period of the initial field study. Subsequently three more sites Ruvu, Mkungwe and Bunduki Forest Reserves were visited and surveyed. A further three sites that the author could not visit, Shikurufumi, Mvuha/Chaminyani, and Kasanga Forest Reserves are included in this report since two observers, N. Doggart and J. Kuire are qualified in identifying *O. garnetti* and *Galagoides udzungwensis* in the field.

1. Kimboza Forest Reserve (S 7°00' 37°45'E)

Due to the lack of time it was not possible to visit Kimboza Forest Reserve.

2. Uluguru North Forest Reserve (S 06°55' 37°43'E)

The site in the Uluguru North FR was visited between the 24th and the 29th February 2000. The campsite was due north north east and one hour walk from Tegetero Mission, the nearest point with road access. The site was approximately 3.5 km due west from Bagiro/Bagilo at an altitude of 1290 m asl. The survey area, was conducted in sub-montane moist forest (Lovett and Pócs 1993) and had 70% to full canopy cover of about 30m height and was on the wetter east facing side of the reserve. There was evidence of old pitsawing sites and fresh pole cutting in the area.

3. Uluguru South Forest Reserve (S 07°06'33" 37°36'22"E)

The field work base site in Uluguru South FR was located approximately 2km east of Tchenzema village at an altitude of 2250m and was visited between the 3rd and the 8th of March 2000. The forest in the area surveyed is montane forest (Lovett and Pócs 1993) at the lower altitudes around 2000m and at higher altitudes 2300m the forest type grades into stunted elfin forest on exposed ridgetops and forest edges and finally to mountain top grassland with elfin forest patches.

The following sites in the Uluguru Mountains, were also visited more recently by the author:

1. Ruvu Forest Reserve (S 07°00'29" 37°57'45"E)

Ruvu FR is a lowland reserve (150-300m) containing mainly mixed woodland and some lowland closed canopy forest and thicket. The author visited the reserve for 3 nights (15/07 – 18/07/2000) however other observers were there for longer (13/07 – 20/07/2000). Along the Ruvu river and other water courses riverine forest is found. One camp was located at 150m asl in an area of lowland forest and another camp was located in riverine forest close to the Ruvu river. Brief surveys were conducted in these habitat types.

2. Mkungwe Forest Reserve (S 06°52'07" 37°54'54"E)

Mkungwe forest, which encompasses a large hill containing a ridge running North to South, was visited between 09/08 – 16/08/2000. The lower slopes contain mixed woodland, changing to lowland forest then sub-montane forest after 800m. Surveys were conducted from one camp at 560m that enabled a survey of the lowland forests and the transition zone to sub-montane forest. The second camp was located on top of the ridge at 1100m, where surveys were conducted in the sub-montane forest. At least ten fresh pitsaw sites were observed indicating a high pressure on timber stocks and limited law enforcement. This forest reserve contains the largest remaining area of sub-montane forest outside the main Uluguru Mountain block where this forest type occurs in a few areas below 1500m in Uluguru North FR.

3. Bunduki Forest Reserve (S 07°01'34" 37°37'53"E)

Bunduki FR is a sub-montane (ranging from 1240m-1540m) forest which is heavily disturbed by logging and by the previous planting of plots of exotic tree species such as *Grevillea robusta* and *Eucalyptus* sp. Two days (28/08 – 31/08/2000) were spent here surveying from old roads that transected parts of the forest.

The following sites in and around the Uluguru Mountains were visited by other field scientists who were able to make galago observations;

1. Shikurufumi Forest Reserve (S 07°09' 37°30'E)

N. Doggart visited this reserve (24/08 – 23/08/2000) which contained a good deal of *Eucalyptus* as well as secondary sub-montane forest.

2. Mvuha and Chaminyani Forest Reserves (S 07°10' 37°50'E)

Mvuha and Chaminyani Forest Reserves share one common border and contain very similar habitat types, effectively making one continuous forest reserve and as such is treated as one in this report. This reserve was visited by N. Doggart and J. Kiure (20/07 – 27/07/2000), and is a lowland reserve dominated mainly by mixed woodland and riverine forest along the water courses.

3. Kasanga Forest Reserve (S 07°10' 37°45'E)

This reserve was visited by N. Doggart (27/07 – 03/08/2000), and contains secondary transitional lowland and sub-montane forest as well as many planted mango trees (altitude at camp 750m).

Methods

1. Tape recordings

Galagos can most easily be identified in the field from their vocalizations. The various types of call made (up to 6 loud call types) depend on the behavioral status of the animal. Calls that signify the presence of one animal to another are known as advertising calls. Other calls mainly signify various states of alarm and possibly curiosity. For the purposes of species identification the advertising calls are of most interest as they are species specific whereas the alarm calls show some degrees of similarity in structure. Tape recordings were made with a Sony WM-C6C tape recorder and Senheiser K6-ME66 directional microphone. All galago calls and other calls of owls, hyrax and mammals are also recorded. Vocalisation data is analysed by a computerised digital sound analyser and compared with a library of calls of other galagos species held at the Nocturnal Primate Research Group, Oxford Brookes University, UK.

2. Observations

Observations are made with the aid of a Petzel headtorch with a halogen bulb. This torch picks out eyeshine that is reflected by nocturnal mammals. Once eyeshine is spotted, a four cell Maglite torch is used with binoculars (Zeiss DDR 10x50W), to obtain observations of the animal(s). Notes are made of the height of the animals in the canopy, use of supporting trees/laines, general behavior and animal interactions.

3. Trap data

Chardonneret traps baited with fruit are used to capture galagos alive and sometimes bat nets are used to catch trap shy species. Traps are checked every 4-6 hours, and animals are extracted by hand without the need for anesthesure. Biometric measurements are taken and tissue samples (from the ear using a biopsy punch and stored in ethanol) are collected for genetic analysis.

4. Population and ecological data

Night walks are conducted along pre-existing paths where possible to reduce noise and disturbance. Galago sightings and/or calls are noted. From this, relative densities are estimated by counting the number of galagos encountered over a measured distance. Given a known distance from the path within which animals can be counted reliably it is possible to estimate the number animals within the area. For bushbabies this figure is approximately 30 meters either side of the path making the survey area along a 100 meter path equal to 6000 meters square. Encounter rates per hour can also give an indicator of relative animal densities as well as activity rates under variable weather conditions and moon phases. Due to variation in animal activity the accuracy of these methods may be low.

5. Any other data.

Other data collected opportunistically include; galago hairs, faeces and locating tree holes or nests where the animals may live during the daytime.

Results

The fieldwork revealed that at both sites in Uluguru North and Uluguru South FRs, only one species of Galago, the Mountain Galago *Galagoides orinus*, was recorded. Surprisingly, Garnett's galago *Otolemur garnetti* was not recorded. During this survey the following data were collected on *G. orinus* (unless otherwise indicated, the information presented below is an amalgamation of data from both sites).

A description of the galago (Galagoides) in the wild based on field observations.

A small galago estimated to be between 80-120 grams with a head and body measurement of 12-14cm and a tail of 14-16cm, was seen on 32 occasions. These animals appeared to be cinnamon brown on the top of the dorsum and flanks with a slight orange brown tinge on the shoulders and thighs. The tail morphology is variable but generally completely uniform in length with the fur the same color as the dorsum apart from a darkening towards the tip. A variation to this was noted in two individuals, which had less, hairy tails and the tail color appeared to be russet or red brown. There appeared to be no morphological differences between the galago populations at different study sites.

Ecological, behavioral and population data.

The 'dwarf galagos' observed and recorded were generally between 2 and 8 meters up in the canopy often in groups of three. In Uluguru North FR most of the animals were seen singly but counter called between other unseen individuals. In Uluguru South FR an unusually high proportion of sightings (compared with other East African *Galagoides* species) were made of animals moving in groups of three. These groups were seen to interact with each other by mutual licking, grooming and playful activities. Animals were seen to use a variety of supports from small vine tangles of less than 1cm in diameter to tree trunks more than forty centimeters in diameter.

In Uluguru North FR the average encounter rate was 2.7 animals per hour ($n = 30$, survey time = 750 minutes over 5 nights [does not include static survey or return journey time], range = 1.3 – 6 animals per hour). The estimated density of animals in this reserve is 4.2 animals per hectare (transect length = 200m, effective survey distance either side of the path = 30m, $n = 5$ [the average number of galagos encountered over three nights surveys on this transect]). The estimated population for the reserve is 3,510 animals (confidence limits = 3,100 – 3,920) (calculated from the animal density and the forest reserve area of 83.56 km²).

In Uluguru South FR the average encounter rate for *G. orinus* was 5.4 animals per hour ($n = 74$, survey time = 818 minutes over 5 nights [does not include static survey or return journey time], range = 4.2 – 8.5 animals per hour). The estimated density of animals in this reserve is 12.2 animals per hectare (transect length = 200m, effective survey distance either side of the path = 30m, $n = 14.6$ [the average number of galagos encountered over three nights surveys on this transect]). The estimated population for this reserve is 17,600 animals (confidence limits = 12,550 – 22,650) (rounded to the nearest 10 and calculated from the animal density and a given area of 144.3 km² [minus 20km² for the unforested Lukwangule plateau]).

Table 3 The vocalization repertoire given by *G. orinus*.

Name of call	Description
'Double unit call'	The double unit call is comprised of two soft units the first unit made at a higher pitch than the second and uttered in a series up to six times at a regular tempo to form a phrase. This is probably the call Honess (1996) describes as the repetitive call but the call heard in the Uluguru differs due the altering pitch levels. This call seemed to be the contact or advertising call of this population and is used to advertise the presence of one animal to another or others in the vicinity as well as for territoriality. Counter calling or replying to this call was often heard sometimes between three animals particularly at dawn and dusk.
'Descending screeches and yaps'	This call is a series of phrased screeches linked in between by yaps (very short high-pitched units). Yaps may be uttered for more than a three minutes before breaking into screeches which only last between five to ten seconds. The whole calling bout may last between five minutes to over one hour. This call is used in intense alarm situations for example when a potential predator is spotted and can be heard throughout the night.
'Buzz'	A strange descending buzz noise lasting one to two seconds sometimes uttered in a descending series or as a start to a series of 'yaps' and/or shrieks depending on the degree of alarm. 'Buzzes' uttered on their own indicate to others mild alarm, surprise or curiosity, possibly when something unusual is come across for example, torchlight.
'Grunt shrieks'	Grunts are a quiet low pitch low volume call made by swallowing air rapidly when uttering screeches at the same time. This call is usually implies extreme alarm due the high amount of physical effort to make this call.
'Yaps'	Very short high pitch dog-like unit, this call is usually uttered in series and in conjunction with other calls like screeches and buzzes.
'High pitch squeaks'	These are very high pitch calls uttered singly or in series of two to three units or breaking into screeches. Often heard high up in the canopy, it is unclear what behavioral context this is made.

The names given to the calls have already been used for describing the vocal repertoires of *Galagoides* species (Bearder *et al.* 1995, Honess and Bearder 1996).

Vocalization data.

Both populations of *G. orinus* in Uluguru North and Uluguru South FRs had the same vocal repertoire. The loud calls are described below and the context in which they were (possibly) made is noted (see Table 3.).

Other Sites

Galagos were recorded at all other study sites in the Uluguru mountains that were visited (see Table 4). The fieldwork in Mkungwe revealed three important discoveries. Firstly the trapping of possibly the second ever *Galagoides orinus* (the first to be captured since the original type specimen was taken in 1926.) that revealed detailed morphological information and allowed genetic samples to be taken. Secondly, another galago, *Galagoides udzungwensis*, was trapped allowing for direct comparisons with *G. orinus* to further confirm the identifications and compare and contrast morphological differences. Thirdly, the recorded of *G. orinus* and *G.*

udzungwensis (see Figure 2 below) occurring sympatrically within a narrow altitudinal band between 550 to 650m, gives new information about the altitudinal range limits of *G. orinus*.

Table 4 Galagos species and the vegetation type recorded in each study site.

Study site/Vegetation type	Sub-montane forest	Lowland forest and thicket	Riverine Forest	Mixed woodland
Ruvu FR	NA	O. g., G. u.	O. g., G. u.	O. g., G. u.
Mkungwe FR	O. g., G. o.	O. g., G. o., G. u.	NA	O. g.,
Bunduki/ FR	O. g.*	NA	NA	NA
Mvuha/Chaminyani FR	NA	O. g., G. u.	O. g., G. u.	O. g.
Shukurufumi FR	O. g., G. u.	NA	NA	NA
Kasanga	NA	<i>Galagoides</i> sp.	NA	NA

NA denotes where a certain vegetation type was not encountered and; O. g. – *Otolemur garnetti*, G. o. - *Galagoides orinus*, G. u. - *Galagoides udzungwensis*.

The other lowland sites revealed more populations of *Otolemur garnetti* and *Galagoides udzungwensis* around the Uluguru Mountains particularly with the relation to habitat type and habitat alteration due to logging or planting of exotic tree species. The advertising calls of *O. garnetti*, the ‘trailing call’ and *G. udzungwensis* ‘the single unit rolling call’ as described in Honess (1996), were heard consistently at these sites.



Figure 2 *G. udzungwensis* (left) and *G. orinus* in the hand.

5. DISCUSSION

The taxonomic status of the species of Galagos in the Uluguru Mountains

From the data available the taxonomic validity of *G. orinus* seems secure. This species is certainly significantly different in terms of pelage and vocalizations to the Congolese type, Demidoff's galago *G. demidovii*. This agrees with the conclusions of Honess and Bearder (1996) and Butynski (1998).

G. orinus is also qualitatively different in terms of vocal repertoires from the other dwarf Galagos occurring in Tanzania, the Matundu *G. udzungwensis*, Grant's *G. granti* and Rondo galago *G. rondoensis*. This species has at least two specifically unique calls, the 'descending shrieks' and the 'double unit call'. The other calls made in the context of alarm, are similar to those made by the other Tanzania dwarf species mentioned above.

Judging from field observations, *G. orinus* seems quite similar in terms of dorsal pelage to *G. udzungwensis*. However, the face and large ears when observed closely seem more similar to *G. rondoensis*. The tail varied from being short, non bushy and russet brown to gray brown, thickly haired and bushy. This variation has also been noted with *G. rondoensis* (Perkin, personal observation.). *G. orinus* does however seem significantly smaller in size at between 80-100g compared to *G. udzungwensis* average weight 135.5g (Honess and Bearder 1996) and *G. granti* average weight 134g (Jenkins 1987). The *G. orinus* trapped in Mkungwe (mean weight over 2 weeks 85g) forest seems more related to *G. rondoensis* and not *G. udzungwensis*, but is definitely unique and distinguishable in terms of its size and morphology.

G. orinus is distinct in terms of habitat preference. This species seems only to occur in moist evergreen forests above 650m (above 800m in the East Usambaras, Perkin Unpub, Honess and Bearder 1996) although the exact altitudinal limit may vary as a function of rainfall, seasonality and forest type. *G. orinus* does not seem to occur sympatrically with *G. udzungwensis* in the areas surveyed, except where sub-montane and lowland forest areas meet as a habitat continuum as observed in Mkungwe FR. The presence of *G. orinus* in Mkungwe FR at such low elevations (550m) could possibly be due to altitudinal migration during the cold season months from June to August. Mkungwe FR is therefore an extremely important site as the only surviving area in the Uluguru Mountains to contain lowland and sub-montane forest as a habitat continuum.

The distinctive vocal repertoire, habitat preference and size would seem to validate this form's specific taxonomic status. In fact, further research may reveal more distinctive forms of *G. orinus* within the Eastern Arc Mountains, due to the long periods of isolation between each mountain block. Variations in vocal repertoires have already been noted (Perkin, unpub) between other sites in the Eastern Arc namely, the Udzungwa, East Usambara, the South Pare Mountains and the Taita Hills.

Conservation Status

G. orinus is officially assigned the Threat Category 'Data Deficient' (IUCN 1994). Honess (1996) proposes to assign *G. orinus* the highest threat category after Oates (1995), 'Threat Category 5 - Critically Endangered' and using the red list system (IUCN 1994) 'Endangered (B1, B2)'. This assessment was not based on any population estimates but more on the perceived degree of threat to the habitat. From a survey in the Udzungwa Mountains, Butynski (1998) however takes into account density estimates combined with available habitat areas and proposed a lesser threat category of 'Vulnerable (B1, B2)' (IUCN 1994).

In the Uluguru Mountains there seems little threat to the *G. orinus* population from hunting and providing the habitat is conserved, the outlook for this species is good. This species does not occur outside the forests. Based on data in this study and others (Butynski 1998 and Perkin unpub) I would propose to keep *G. orinus* within the threat category status of 'Vulnerable (B1, B2) (IUCN 1994) or 'Threat category 3 - Vulnerable' after Oates (1995). This takes into account that the population may exceed 100,000 throughout all the Eastern Arc Mountain forests however, these forests are unique in their own right and are highly fragmented and threatened. Further research will no doubt lead to more accurate population estimates but equally may reveal new specifically distinct forms of *G. orinus*. However, threat categories should be assigned based on the existing data and not future speculation, but the diversity of these fragmented and isolated populations should not be forgotten.

Importance of the Ulugurus for *G. orinus*

The results indicate a combined population for *G. orinus* between Uluguru North and Uluguru South Forest Reserves of at least 23,000 animals. Uluguru South FR contains the greater proportion of the population of at least 17,000 (between 12,550 – 22,650) animals. These estimates are likely to be very conservative as well as very approximate due to the lack of robustness of the methodology and the variables (for example, moon phase and habitat variation). This species was recorded to occur at greater densities at higher altitudes (5.4 animals per hour in Uluguru South FR between 2000 and 2500 m asl, and 2.8 animals per hour in Uluguru North FRs between 1,000m and 1,300 asl.) The population estimate for Uluguru North FR, which has an altitudinal range between 1000 to 2340m asl., is likely to be higher if it is assumed that there are greater densities at higher altitudes. Given that *G. orinus* occurs as low as 550 m as in Mkungwe FR, this indicates how many may have been lost due to the extensive forest clearance on the slopes of the Uluguru Mountains.

Taking into account the size of the other remaining Eastern Arc forests, the population size of *G. orinus* may only just exceed 100,000, which indicates the significance of the Uluguru Mountain's population. This figure alone does not take into account the diversity of each population within the Eastern Arc Mountains (Lovett and Wasser 1992), therefore each isolated population of this species is very important. Recent studies on the Mountain Greenbul *Androparus montanus*, for example, have revealed the extent of genetic and vocal variation (Roy *et al.* 1998) between populations of this species on different Eastern Arc mountain blocks. Some of these could in the future be described as new species.

Other galago species

During this study, the two other species of galago that may occur in Uluguru North and South FR *O. garnetti* and *G. udzungwensis* were not found. This is a surprising result for *O. garnetti* given the suggested range from other studies (Kingdon 1997). The habitat isolation of Uluguru North and South FR from the lowland forests where both *O. garnetti* and *G. udzungwensis* occur, may be a factor. Both these species have been recorded in Kimboza FR (Honest 1996, Perkin pers. obs.) and other lowland forests visited (see table 4).

6. FINAL CONCLUSIONS AND RECOMMENDATIONS

Two main conclusions concerning the galagos, principally *G. orinus* can be made as a result of this study.

Firstly, the conservation of *G. orinus* is entirely dependent on the maintenance of the forest habitat. There is some evidence (Perkin unpub.) that dwarf galagos can tolerate a degree of habitat disturbance for example, low levels of pole cutting and pit-sawing. The most important areas for *G. orinus* conservation are; Uluguru North FR, Uluguru South FR and Mkungwe FR.

Secondly, further research is required on *G. orinus* (and other galago species) in the following areas:

1. Obtaining specimens and tissue samples for genetic and morphometric analysis.
2. Identifying any other populations and conducting population surveys.
3. Obtaining further vocalization data for each species and population.

From this it will be possible to begin to understand the level of taxonomic uniqueness of each population of *G. orinus* in the Eastern Arc Mountains as well as their conservation status.

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8. APPENDIX 1.

Table 1. The following morphological data is known about the mountain galago *Galagoides orinus* from the type description by Lawrence and Washburn, (1936).

Type specimen	Adult male, specimen number 22453; Museum of Comparative Zoology, Harvard University, USA.
Measurements	
Weight	Not available
Head - body	Not available
Tail	Not available
Ear	Not available
Hind foot	47.7mm (n=1)
Morphology	
Dorsum	“Back, top of head, dorsal surface of arms and legs ‘mummy brown’. The hairs are tipped with ‘Vandyke brown;’ and have a narrow subterminal; ring of pale ‘mummy brown’; the bases are ‘blackish slate’.”
Ventrum	“Belly washed with ‘buff-yellow’, becoming whitish on the underside of the hind limbs and the upper arms and darkening on the throat, chin and cheeks to ‘orange-buff’.
Face	Not available
Tail	“deep ‘russet’ at the base becoming darker at the tip, individually hair only slightly paler at bases” and “The tail is noticeably short-haired.”
Hair structure	Not available
Penile morphology	Not available
Cranial structure and dimensions	
Greatest length	39.2mm
Basal length	27.4mm
Zygotic length	Not available
Mastoid breadth	18.9mm
Brain case height	Not available
Palate length	14.0mm
Front of canine to back of m ³	13.7mm (length of upper cheek teeth)