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Taxonomy, Distribution, and Conservation Status of Three Species of Dwarf Galagos (*Galagoides*) in Eastern Africa

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Abstract: This paper reviews the complicated nomenclatural history for the Kenya coast galago, *Galagoides* cf. *cocos*, and examines whether '*cocos*' is the valid species name for this recently resurrected taxon. This paper also reviews the phenotypic and vocal differences among *G. cocos*; the Zanzibar galago (*Galagoides zanzibaricus zanzibaricus*); the Udzungwa galago (*Galagoides zanzibaricus udzungwensis*); and the Mozambique galago (*Galagoides granti*), as well as their geographic ranges and conservation status. The following are among the findings: (1) '*Galagoides cocos*' is the name that should be applied to the Kenya coast galago; (2) in the field, the loud calls of these three species are diagnostic and remain the best means for identification; (3) there is a suite of phenotypic characters that, when taken together, can be used to distinguish among these three species when in the hand or viewed in the field in good light at close range; (4) *G. z. zanzibaricus* is phenotypically distinct from *G. z. udzungwensis*; (5) the three species are parapatric or, perhaps, narrowly sympatric; (6) the three species are endemic to the coastal forests of eastern Africa with *G. cocos* in the north (Kenya and northeastern Tanzania), *G. zanzibaricus* in Tanzania, and *G. granti* from southern Tanzania to southern Mozambique; and (7) none of the three species is threatened at this time, although *G. z. zanzibaricus* meets the *IUCN Red List* criteria for an Endangered subspecies.
Key Words: Dwarf galagos, *Galagoides*, *cocos*, *granti*, *zanzibaricus*, *udzungwensis*, taxonomy, conservation

Introduction

Many of the species and subspecies of the family Galagidae (galagos or bushbabies) have been subjected to repeated taxonomic revisions and name changes over the past century (for example, Elliot 1913; Allen 1939; Hill 1953; Groves 1977, 1993, 2001, 2005; Grubb *et al.* 2003). The Kenya coast galago (or Diani small galago), *Galagoides cocos*, is no exception (Figs. 1 and 2). *Galagoides cocos* is a recently revived, highly cryptic species of the coastal forest of eastern Africa.

In this paper we (1) review the nomenclatural history for the Kenya coast galago, (2) provide new information that confirms that '*cocos*' is the valid name for this recently revived species, (3) summarize the phenotypic and the main qualitative vocal differences among *G. cocos*, the Zanzibar galago (*Galagoides zanzibaricus*), and the Mozambique or Grant's galago (*Galagoides granti*), (4) review their geographic ranges, and (5) examine their conservation status (Figs. 1–7).

Nomenclatural History for the Kenya Coast Galago

On 16 December 1911, Edmund Heller (1912) collected an adult male dwarf galago (one of 10 specimens) at Mazeras, Kenya, which he named *Galago moholi cocos.* This taxon was raised to species status (*Galago cocos*) by Elliot (1913), but later placed as a subspecies of the Somali galago (*Galago gallarum cocos*), as a subspecies of the Zanzibar galago (*Galago zanzibaricus cocos*), or simply not recognized as a valid taxon and placed as a junior synonym of the Zanzibar galago (*Galago senegalensis zanzibaricus* or *Galago zanzibaricus zanzibaricus* or *Galago zanzibaricus* or *Galagoides zanzibaricus*) (Table 1). Most recently, this taxon has been provisionally referred to as '*Galagoides* cf. *cocos*' (Bearder *et al*. 2003; Grubb *et al*. 2003). This binomial is 'provisional' because the validity of the use of the name '*cocos*' requires confirmation.

Figure 1. Adult (sex not known) Kenya coast galago (*Galagoides cocos*) from Arabuko-Sokoke Forest Reserve, southeastern Kenya (near Gedi). Note the muzzle patches and buffy-brown dorsum. Photograph by Harald Schuetz.

Figure 2. Adult female Kenya coast galago (*Galagoides cocos*) from Diani, southeastern Kenya. Note the muzzle patches. Photograph by Andrew Perkin.

Figure 3. Adult male Zanzibar galago (*Galagoides zanzibaricus udzungwensis*) from Pande Game Reserve, Tanzania (near Dar es Salaam). Note the absence of muzzle patches. Photograph by Nike Doggart.

Figure 4. Adult (sex not known) Udzungwa (or Matundu) galago (*Galagoides zanzibaricus udzungwensis*) from Matundu Forest Reserve, Udzungwa Mountains, south-central Tanzania (near Ifakara). Note that the hairs of the tail are of even length, sparse, and wiry, that the bone of the tail is visible, and that the tip of the tail is dusky. Photograph from Honess (1996).

Many of the more recent taxonomic studies on Galagidae make no mention of *cocos,* but presumably they consider *cocos* to be a synonym of *Galago zanzibaricus* (for example, Groves 1977; Nash *et al.* 1989; Masters 1998; Zimmermann 1990) or of *Galagoides zanzibaricus* (for example, Honess 1996; Anderson 1999, 2000; DelPero *et al*. 2000; Masters and Bragg 2000; Masters and Brothers 2002).

Figure 5. Adult (sex not known) Mozambique galago (*Galagoides granti*) from Rondo Forest Reserve, southeastern Tanzania (near Lindi). This individual is emerging from a tree hole and, thus, its tail is not visible. Note the relatively large, blackish ears and buffy-brown dorsum. Photograph by Simon Bearder.

Figure 6. Typical adults of three *Galagoides* spp. at the British Museum of Natural History, London. Bottom to top: Kenya coast galago (*Galagoides cocos*) from Gande, Kenya, Udzungwa galago (*Galagoides zanzibaricus udzungwensis*) from Kissarawe, Tanzania, and Mozambique galago (*Galagoides granti*) from Coguno, Mozambique. Note the great similarity in the color of the dorsum, and that *G. granti* is the largest of the three species and has a wider, fuller, tail. Photograph by Tom Butynski.

The Need for Confirmation of the Name '*cocos*' for the Kenya Coast Galago

Until recently, *G. zanzibaricus* was considered a polytypic species of the coastal forests from southern Somalia through Kenya and Tanzania (including Unguja Island, Zanzibar, Tanzania) to southern Mozambique, and inland to central

Table 1. Summary of the nomenclature changes for the Kenya coast galago (*Galagoides cocos*).

Authority	Latin name
Heller (1912)	*Galago moholi cocos*
Elliot (1913), Hollister (1924)	*Galago cocos*
Allen and Loveridge (1927)	*Galago gallarum cocos*
Schwarz (1931), Hill (1953), Allen (1939), Hill and Meester (1977)	*cocos* a synonym of *Galago senegalensis zanzibaricus*
Jenkins (1987)	*cocos* a synonym of *Galago zanzibaricus zanzibaricus*
Kingdon (1971, 1997), Groves (2005)	*cocos* a synonym of *Galago zanzibaricus*
Groves (1993)	*cocos* a synonym of *Galagoides zanzibaricus*
Groves (2001)	*Galago zanzibaricus cocos*
Bearder *et al.* (2003), Grubb *et al.* (2003)	*Galagoides cocos*

Figure 7. Two adult Zanzibar galagos (*Galagoides zanzibaricus zanzibaricus*) (left) from Unguja Island, Zanzibar, Tanzania, and two adult Udzungwa galagos (*Galagoides zanzibaricus udzungwensis*) (right) from Kissarawe, Tanzania. All four specimens are at the British Museum of Natural History (BMNH), London. The two specimens of *G. z. zanzibaricus* represent the extremes in pelage coloration among the 10 adult specimens at the BMNH. Note that the dorsum, tail, and outer front limbs are medium to bright cinnamon in *G. z. zanzibaricus* and buffy-brown in *G. z. udzungwensis*. Photograph by Tom Butynski.

Tanzania, Malawi, and extreme eastern Zimbabwe (Hill 1953; Groves 1977; Hill and Meester 1977; Smithers and Wilson 1979; Jenkins 1987; Courtenay and Bearder 1989; Skinner and Smithers 1990; Groves 2001, 2005; Bearder *et al*. 2003; Grubb *et al.* 2003). The ecology, behavior, and vocal repertoire of the mainland subspecies, *G. z. cocos*, is well known, having been the focus of detailed field studies at Diani and Gedi Forests, Kenya (Harcourt 1986; Harcourt and Nash 1986a, 1986b). Far less well known is the nominotypical subspecies, *G. z. zanzibaricus*, an endemic of Unguja Island, Zanzibar. It was not until A. Perkin visited Unguja Island in 1998 and recorded the species-specific advertising call of topotypical *G. zanzibaricus* (Fig. 8) that it became clear that these two forms were different:

(1) The species-specific advertising call of *G. z. zanzibaricus* is very different from that of *G. z. cocos*. *Galagoides z. zanzibaricus* has a 'single unit rolling call' (Fig. 8), and *G. z. cocos* has an 'incremental call' (Fig. 9) (Honess 1996; Honess and Bearder 1996; Perkin *et al.* 2002; Grubb *et al*. 2003).

(2) The species-specific advertising call of *G. z. zanzibaricus* is identical, or nearly so, to the species-specific advertising call of the recently named Udzungwa (or Matundu) galago, *Galagoides udzungwensis* (see A. Perkin unpubl. data, cited in Bearder 1999). This led to the realization that *G. udzungwensis* may not be a new species, but rather synonymous with, or a subspecies of, *G. zanzibaricus* (see Perkin *et al*. 2002; Bearder *et al*. 2003; Grubb *et al*. 2003). Here we treat the Udzungwa galago as a distinct mainland subspecies (*G. z. udzungwensis*), but emphasize that the taxonomic status of the Udzungwa galago is far from resolved (see below).

Based on a considerable body of knowledge concerning the species-specific advertising calls of the Galagidae, and their wide use and acceptance as a robust species recognition and taxonomic tool (Zimmermann *et al*. 1988; Courtenay and Bearder 1989; Harcourt and Bearder 1989; Nash *et al.* 1989; Zimmermann 1990; Masters 1991; Bearder *et al*. 1995, 2003; Honess 1996; Honess and Bearder 1996; Butynski *et al*. 1998; Ambrose 1999, 2003; Bearder 1999; Groves 2001; Perkin *et al*. 2002), it was judged that the level of difference between the advertising calls of *G. z. cocos* and *G. z. zanzibaricus/G. z. udzungwensis* is far greater than can be accommodated at the subspecies level. In fact, the advertising call of *G. z. cocos* is far more similar to the advertising 'incremental' call of *G. granti* (formerly *G. zanzibaricus granti*) (Fig. 10) than it is to the 'single unit rolling' call of *G. z. zanzibaricus* (see Bearder *et al*. 1995). As such, *G. z. cocos* was reassigned species status, *G.* cf. *cocos* (Bearder *et al*. 2003; Grubb *et al*. 2003). Interestingly, the geographic range of *G. zanzibaricus* is located between the geographic ranges of *G. cocos* and *G. granti* (see below).

Grubb and co-authors give a succinct overview of this complex situation.

> "Galagos at Diani, which were thought to be *Galagoides zanzibaricus* (Harcourt and Nash, 1986a, b) are vocally distinct from true or topotypical *G. zanzibaricus* of Zanzibar. They are provisionally identified as *Galagoides* cf. *cocos*, and we assign them to the *G. granti* group. Galagos from the Udzungwa Mtns and other localities in Tanzania have been named *Galagoides udzungwensis* (Honess, 1996) but, on the basis of their vocalization, do not differ from those of topotypical *G. zanzibaricus* of Zanzibar (A. Perkin unpubl. data, cited in Bearder, 1999). The form *udzungwensis* may prove to be a valid taxon at the subspecific level but until the systematics is clarified, we relegate it to the synonymy of *Galagoides zanzibaricus*." (Grubb *et al*. 2003, pp.1315–1316).

And below

> "The galago recorded from Diani is vocally distinct from *Galagoides zanzibaricus* and has been

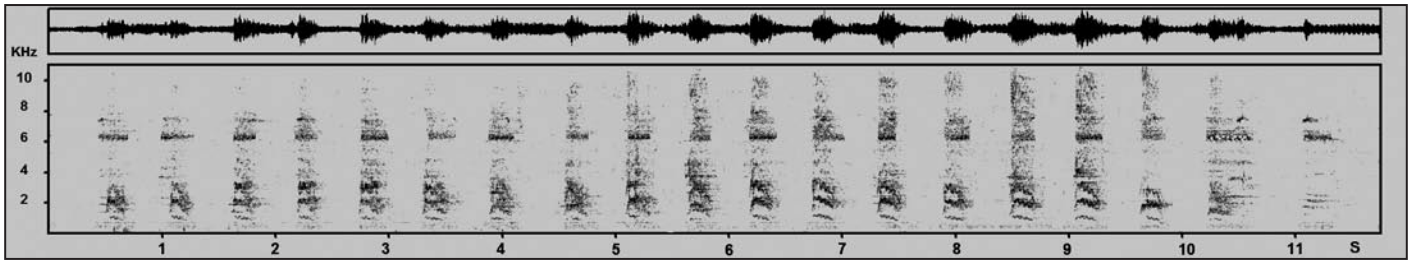

Figure 8. Sonogram and oscillogram of the 'single unit rolling' advertising call of the Zanzibar galago (*Galagoides zanzibaricus zanzibaricus*) from Unguja Island, Zanzibar, Tanzania, the type locality for this species. Call recorded by Andrew Perkin. This call is comprised of a series of 'rolling' trill units that, after a few units, increase in frequency and amplitude before reaching a mild crescendo and then trailing off with trill units of lower amplitude and frequency. The lowering of the frequency is achieved by eliminating the higher frequency elements. The lowest frequency elements remain constant. Each trill unit is made up of a very rapid series of trill subunits. The number of units per 'single unit rolling' call varies considerably (Honess 1996; A. Perkin, pers. obs.). For the above recording: Call length = 10.8 seconds. Frequency range = 0.62–11.12 kHz. Fundamental frequency = 0.75 kHz. Range of unit frequency modulation = 0.81–3.57 kHz. Number of phrases = 0. Number of units = 19. For the Udzungwa galago (*Galagoides zanzibaricus udzungwensis*) population in the Matundu Forest Reserve, south-central Tanzania, the type locality for this subspecies: Mean number of units per single unit rolling call = 14 (SE = 0.17, range = 1–46, n = 2,122). Mean unit interval = 0.28 seconds (n = 181). Mean unit length = 0.22 seconds (n = 196). Range of fundamental frequency = 0.95 to 1.00 kHz (Honess 1996, Honess and Bearder 1996, A. Perkin unpubl. data). Oscillograms of the single unit rolling call of *G. z. udzungwensis* are presented in Bearder *et al*. (1995), Honess (1996), Honess and Bearder (1996), and Kingdon (1997).

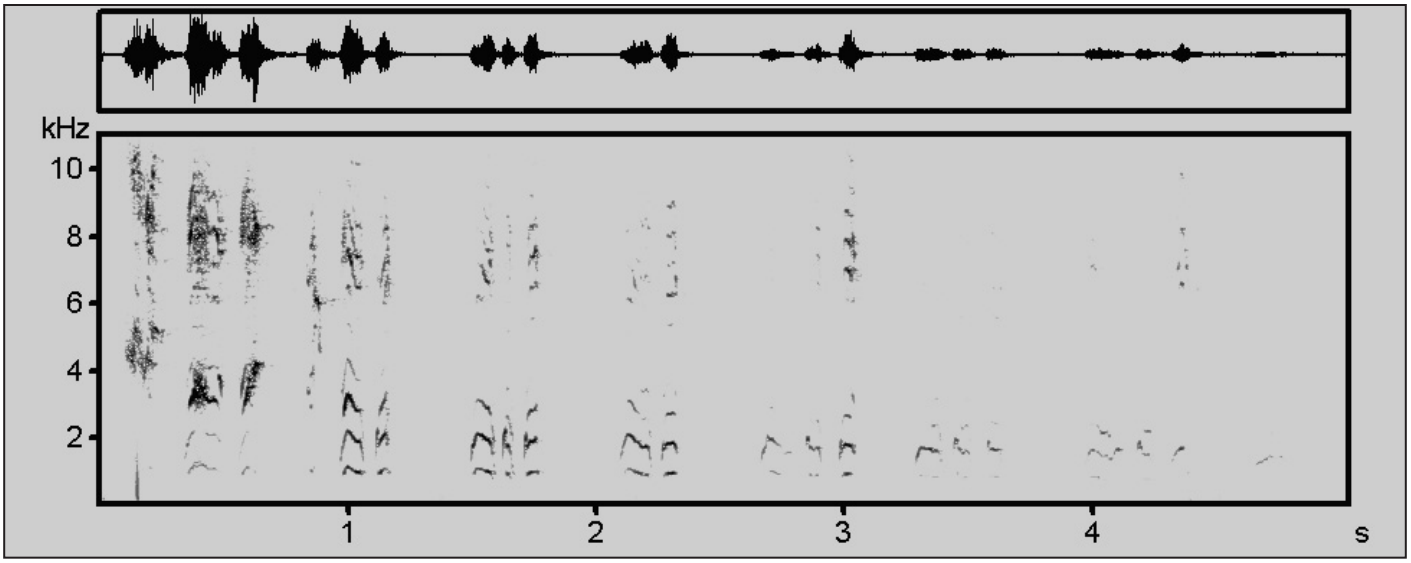

Figure 9. Sonogram and oscillogram of the 'incremental' advertising call of the Kenya coast galago (*Galagoides cocos*) from Diani Beach, southeastern Kenya. Call recorded by Simon Bearder. This call often, but not always, starts with a series of high-pitched, rapidly uttered, "chirrups" followed by units arranged in phrases that are high in frequency and amplitude, and that gradually become lower in amplitude. The number of units within each phrase increases incrementally until the end of the call. Often, as in this case, phrases with same number of units are repeated. The number of units per phrase rarely decreases. Units are often frequency modulated. For the above recording: Call length = 4.7 seconds. Frequency range = 0.65–11.15 kHz. Fundamental frequency = 0.98 kHz. Range of unit frequency modulation = 0.68–10.37 kHz. Number of phrases = 6 (with three introductory "chirrup" units and one incipient unit at the end). Mean number of units per phrase = 2.8. For the *G. cocos* population at Diani: Mean call length = 4.3 seconds (range = 1.7–8.6 seconds, n = 12). Frequency range = 0.8–9.3 kHz. Fundamental frequency = 0.8–1.2 kHz. Mean number of phrases = 6 (range = 3–11, n = 13). Mean number of units per phrase = 2.5 (range 1–11, n = 60). Mean unit interval = 0.35 seconds (range 0.20–0.59 seconds, n = 27). Mean unit length = 0.41 seconds (range 0.15–0.57 seconds, n = 33) (Courtenay and Bearder 1989). See also the acoustic measurements presented in Zimmermann (1990). Additional sonograms and oscillograms of the incremental advertising call, and other calls of *G. cocos,* are presented in Courtenay and Bearder (1989), Harcourt and Bearder (1989), Zimmermann (1990), Bearder *et al.* (1995), and Kingdon (1997).

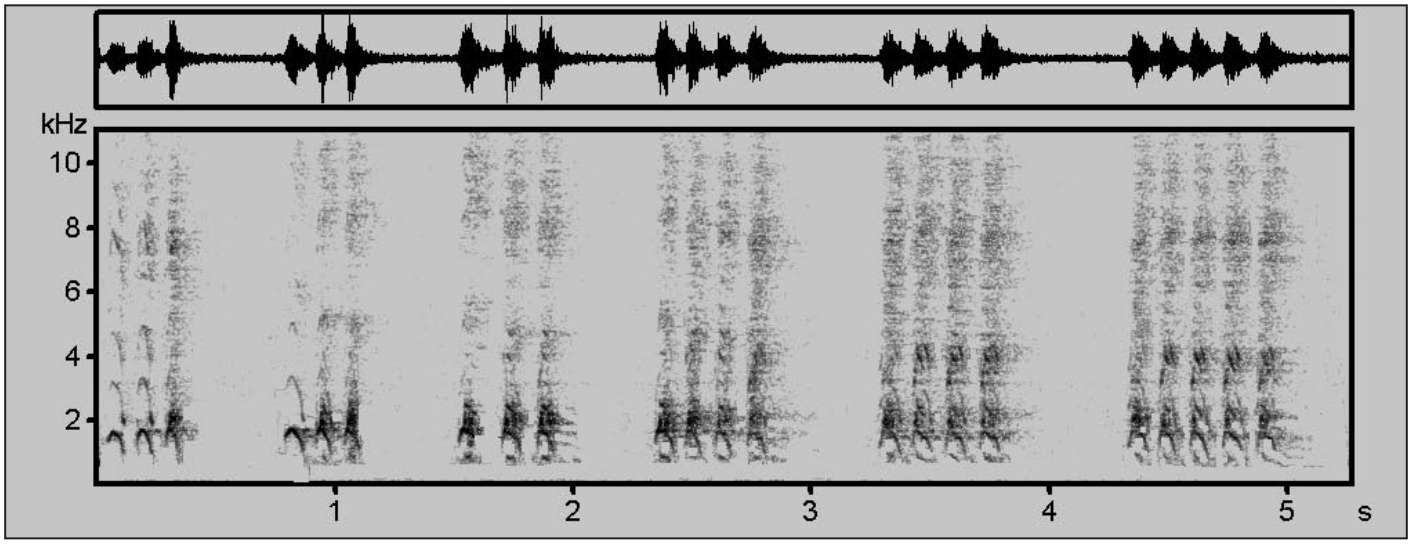

Figure 10. Sonogram and oscillogram of the incremental advertising call of the Mozambique galago (*Galagoides granti*) from Rondo Forest Reserve, Rondo Plateau, southeastern Tanzania (near Lindi). Call recorded by Paul Honess. This sonogram is an example of a full incremental call in which the numbers of units in each phase gradually increase incrementally. Compared with the incremental call of *G. cocos*, the incremental call of *G. granti* maintains relatively consistent amplitude, has more units per phrase, and is more staccato. In the above example, the amplitude increases slightly during the middle phrases and decreases slightly during the last phrase. For the above recording: Call length = 4.9 seconds. Frequency range = 0.56–11.18 kHz. Fundamental frequency = 0.75 kHz. Range of unit frequency modulation = 1.03–5.08 kHz. Number of phrases = 6. Mean number of units per phrase = 3.6 (range 3–5). In the *G. granti* population of the Rondo Forest Reserve: Mean number of phrases per incremental call = 5.8 (SE = 0.2, range = 1–17, n = 211). Mean unit interval = 0.55 seconds (n = 41). Mean unit length = 0.41 seconds (n = 53) (Honess 1996, Honess and Bearder 1996). Additional oscillograms of the incremental advertising call, and other calls, of *G. granti* are presented in Honess (1996), Honess and Bearder (1996), and Kingdon (1997).

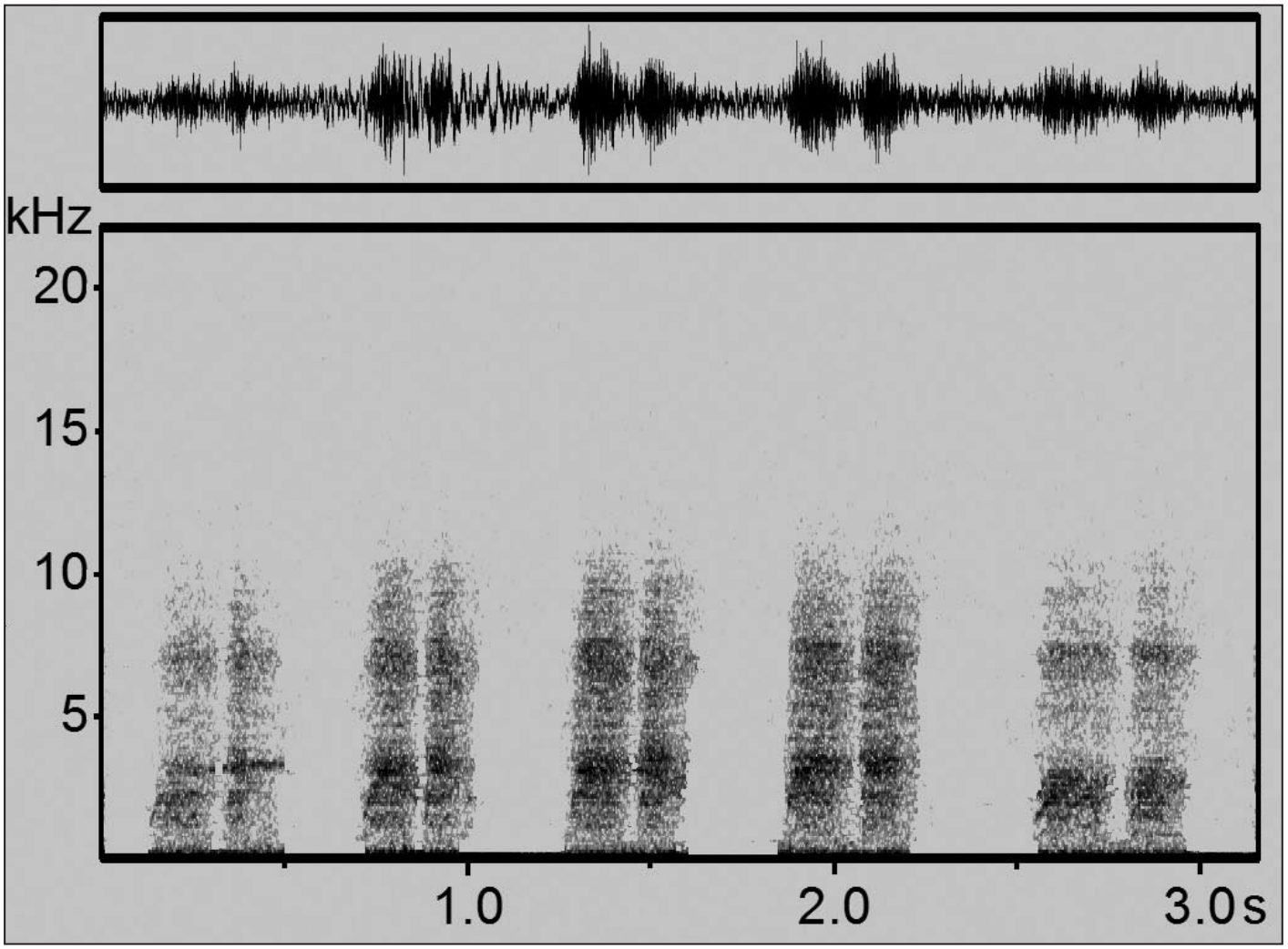

Figure 11. Sonogram and oscillogram of the incremental advertising call of the Kenya coast galago (*Galagoides cocos*) from Kaya Chijembeni (Rabai), 4 km northeast of Mazeras, southeastern Kenya, the type locality for this species. Call recorded by Yvonne de Jong and Tom Butynski. Although numerous full incremental calls were heard and recorded at Kaya Chijembeni during two nights, there was much background noise and wind, and none of the recordings of the full incremental call were suitable for the production of a clear sonogram. The sonogram presented here is of an incomplete or incipient incremental call. Nonetheless, the first five phrases of incremental units are present and identifiable as the species-specific advertising call of *G. cocos*. In this case, there are no "chirrup" phrases and the number of units does not increase incrementally but the call still follows the typical high-pitched, rapid or staccato pattern of the *G. cocos* incremental call. For the above recording: Call length = 2.8 seconds. Frequency range = 0.98–12.4 kHz. Fundamental frequency = 0.77 kHz. Number of phrases = 5. Number of units per phrase = 2. Frequency modulation is not detectable, probably due to the low amplitude of the call.

recorded elsewhere in Kenya and in Tanzania, where A. Perkin (*in litt*.) reported it from the northern tip of the East Usambara Mtns, seemingly close to *G. zanzibaricus* (Table IV). The form *Galago moholi cocos* Heller, 1912, was described from Mazeras (Manzeras), relatively close to Diani (Table IV). Groves (2001) recognized *cocos* as a mainland form of *Galagoides zanzibaricus*. Vocalizations typical of *G. zanzibaricus* have not been recorded in Kenya. Therefore, it seems highly likely that the Diani galago is a separate species, *Galagoides* cf. *cocos*. Nevertheless it is important to confirm this. Vocalizations recorded from as near to the type locality of *Galagoides cocos* as possible should be compared with the voice of the Diani galago. The forest at the type locality (Kaya Mazeras) has been destroyed, but forests 5 km and 20 km distant (Kaya Mtswakana and Kaya Fungo respectively) and some others might be visited (Butynski unpubl., including information from Q. Luke). Museum specimens of *Galagoides cocos* should be compared with the Diani galago further to ensure that we are dealing with a single taxon. We provisionally consider the Diani galago to be conspecific with *Galagoides cocos*, under the vernacular name Kenya coast galago." (Grubb *et al*. 2003, p.1317).

In other words, in considering the Kenya coast galago once again a valid species, one important action remains: the confirmation of '*cocos'* as the species name. This is necessary because the tape recordings used to describe the loud call for the Kenya coast galago were made at Diani, Kenya (04°18′S, 39°35′E) (Zimmermann 1990; Bearder *et al*. 1995), *c*.40 km south of the type locality for *G. cocos* (i.e., Mazeras). There are three rivers between these two sites that are potential barri-

ers to dispersal (Maji ya Chumvi, Mambome, and Pemba/Cha Shimba). A visit to Mazeras was, therefore, required to determine whether the species-specific loud call of *G. cocos* at the type locality is the same as that of the dwarf galago at Diani.

Note that, in the above quotation, Grubb *et al*. (2003) assume that the holotype of *G. cocos* was collected in the forest of 'Kaya Mazeras', which has since been destroyed. What Heller (1912) actually says about the type locality is:

> "The Mazeras specimens were all obtained on the brushy borders of the cocoa-palm groves. These groves are the dominant feature in the landscape of the coast belt, and extend almost unbroken from the sea beaches inland a distance of ten or fifteen miles. They mark the tropical littoral zone more precisely than any other plant growth." (Heller 1912, p.2).

In short, Heller obtained the holotype (and nine other specimens) of *G. cocos* in an area of coconut palms (*Cocos nucifera*) and bushland, and not in forest.

Confirmation of the Name '*cocos*' for the Kenya Coast Galago

T. Butynski and Y. de Jong visited the Mazeras area on 10–12 February 2004. The first night was spent searching for *G. cocos* in the Mazeras Botanical Garden (03°57′58″S, 39°33′05″E, 134 m a.s.l.) in Mazeras town. No dwarf galagos were heard or seen, although the small-eared greater galago, (*Otolemur garnettii*), was common (about eight individuals seen or heard).

The second night was spent searching for *G. cocos* on the edge of Kaya Chijembeni (Rabai) (03°56′42″S, 39°34′54″E, 210 m a.s.l.), a relatively large coastal forest located about 4 km northeast of Mazeras town, 17 km from the Indian Ocean, and 40 km north of Diani. Coconut palms are an extremely common species there on the forest edge and, with cashew nut (*Anacardium occidentale*) and mango (*Mangifera indica*), are scattered throughout the farmlands and bush lands that surround Kaya Chijembeni. Many dwarf galagos were heard and seen at this site (both on the forest edge and inside the forest), and tape recordings were acquired of 'incremental' advertising calls and other vocalizations. To our ears, the advertising call recorded in Kaya Chijembeni matched that recorded for the dwarf galago at Diani, as well as the advertising call that T. Butynski has heard many hundreds of times (and recorded) at others sites on the coast of Kenya (for example, Kilifi, Watamu, Gedi), and in forests along the lower Tana River (02°30′S, 40°30′E), *c*.150 km to the north of Mazeras.

That the incremental advertising call recorded from *G. cocos* at Kaya Chijembeni is the same as that recorded from the dwarf galago at Diani is confirmed through comparisons of the sonograms and oscillograms of these calls (Figs. 9 and 11). The advertising calls from these two sites have a very similar incremental structure pattern, frequency range, and call duration.

T. Butynski and Y. de Jong heard about 100 *G. cocos* incremental calls during one night at Kaya Chijembeni. As at other sites where *C. cocos* is similarly common, there was a distinct 'dusk chorus' (*c.* 19:05–19:15h) of incremental calls, a much lower rate of incremental calls throughout the night, and a slight 'dawn chorus' (*c.* 05:45–05:55h) of incremental calls.

The only other species of galago heard at Kaya Chijembeni was *O. garnettii*. Thus, only two species of galagos were seen or heard in the Mazeras/Kaya Chijembeni/Rabai area — *G. cocos* and *O. garnettii.* Y. de Jong and T. Butynski returned to Kaya Chijembeni on 20 February 2006 to obtain better (digital) recordings of the dwarf galago (Fig. 11). Again, the only galagos heard were *G. cocos* and *O. garnettii*.

Incremental calls identical to those of topotypical *G. cocos* at Mazeras have been recorded (by A. Perkin, T. Butynski, Y. de Jong, S. Bearder, N. Cordiero, N. Svoboda, A. Kempson and S. Gregory) at several localities along the Kenya coast both north and south of Mazeras, as well as in the northern lowland coastal forests of the East Usambara Mountains in northeastern Tanzania. These calls were analyzed by A. Perkin and S. Bearder.

Visual examination of the type *G. cocos* and eight other adult specimens of *G. cocos* from Mazeras (housed at the United States National Museum, Washington, DC) reveal that they are not phenotypically different from the three specimens of *G. cocos* at the National Museums of Kenya that were collected along the Tana River (NMK 992), and on the Kenya coast at Gedi (NMK 5351) and Kipendi (no specimen number). One of the specimens at the National Museums of Kenya (MR14) was collected at Mrima Hill, Kenya, very near the border with Tanzania. This specimen has an intact penis, the morphology of which helps to identify this population as *G. cocos* (see below).

We conclude that there is now no doubt that the type of *G. cocos* that Heller (1912) described from Mazeras is conspecific with the dwarf galago found along much of the coast of Kenya and into northern Tanzania. In short, the name '*cocos*' can correctly be used as the species name of the Kenya coast galago.

This clarification of the correct name for the Kenya coast galago has at least three important implications for previous research conducted on *G. cocos*, *G. zanzibaricus*, and *G. granti*. First, most of the field research that has been conducted on the distribution, abundance, behavior, and ecology of '*G. zanzibaricus'* was, in fact, conducted on *G. cocos* (for example, Harcourt 1984, 1986; Harcourt and Nash 1986a, 1986b; Harcourt and Bearder 1989). Second, the distinctive rolling calls of galagos on mainland Tanzania that led Honess (1996) and Honess and Bearder (1996) to name this form *G. udzungwensis*, belong to *G. zanzibaricus* (i.e., *G. z. udzungwensis*). Third, those researchers who obtained data from specimens initially assigned to '*G. zanzibaricus*' have sometimes, unknowingly, combined data from two species (*G. cocos* and *G. zanzibaricus*), and, on occasion, from a third species (*G. granti*). This is especially the case for specimens collected from coastal Kenya, from coastal Tanzania south of

the East Usambara Mountains, and from Unguja Island, Zanzibar. This means that (1) the results and conclusions of some previous studies of '*G. zanzibaricus*' may need to be reviewed and reevaluated, and (2) that the providence of each and every specimen labeled '*G. zanzibaricus*' must be known in order to help ensure that the specimen is not, in fact, *G. cocos* or *G. granti*.

Morphological Differences Among *G. cocos, G. zanzibaricus* and *G. granti*

Galagoides cocos, *G. zanzibaricus*, and *G. granti* are among the most cryptic of primate species. That they are similar phenotypically and morphologically is demonstrated by the inability of some of the foremost primate taxonomists of their time to differentiate among them. For example, Schwarz (1931), in reference to *G. senegalensis zanzibaricus,* states (p. 56):

> "There can be no doubt that Heller's *cocos* is identical with this race. The size, coloration, and the large upper M^3 are found both in the series at Berlin and the one of *cocos* studied by Heller and Hollister. By the identification of the two the known range of *zanzibaricus* is considerably extended. There is no difference between the island and coast specimens."

What is needed next is a detailed comparison of large numbers of *G. cocos* and *G. zanzibaricus* specimens to determine their morphological differences, coupled with ecological, behavioral, acoustic, and molecular studies. Other than the highly distinctive species-specific advertising call, one of the differences noted thus far is that *G. cocos* is slightly larger than *G. z. zanzibaricus*. For example, the mean length of the head+body for *G. cocos* from southeast Kenya and northeast Tanzania is 158 mm (n = 46, range = 142–183 mm) (Appendix I, Tables A and B), while the mean length of the head+body for *G. z. zanzibaricus* from Unguja Island, Zanzibar, is 143 mm (n = 11, range 125–150) (Appendix I, Table C). This size difference extends to body weight; *G. cocos* has a mean body weight of 144 g (n = 78, range = 117–172), whereas *G. z. zanzibaricus* has a mean body weight of 127 g (n = 10, range = 104–172).

Of the two subspecies of *G. zanzibaricus*, it appears that the island form, *G. z. zanzibaricus,* is smaller than the mainland form, *G. z. udzungwensis* (Appendix I, Tables C and D). Mean length of the head+body for *G. z. udzungwensis* is 162 mm (n = 17, range = 139–180) and mean body weight is 145 g (n = 6, range = 118–105). The data available suggest that *G. granti* is larger than *G. z. zanzibaricus*, and very similar in size to *G. z. udzungwensis* and *G. cocos* (Appendix I, Tables E, F and G).

Color of the nose stripe, chin, throat, cheeks and ventrum, length of the nose stripe, and length of the tail relative to length of the head+body, have all been proposed as useful for distinguishing among *G. cocos*, *G. z. zanzibaricus*, *G. z. udzungwensis*, and *G. granti* (for example, Elliot 1913; Nash *et al*. 1989; Honess 1996; Groves 2001). However, our studies lead us to conclude that there is (1) too much intraspecific variation and, especially, (2) too much interspecific overlap for these characters to serve as diagnostic features.

The full range of phenotypic variation present in *G. cocos*, *G. z. zanzibaricus*, *G. z. udzungwensis*, and *G. granti* remains unknown. Although they need to be examined quantitatively, and with sample sizes far larger than those currently available, the following phenotypic characters hold promise for distinguishing among *G. cocos*, *G. z. zanzibaricus*, *G. z. udzungwensis*, and *G. granti*, especially when taken together:

Muzzle patches
G. cocos – patch on either side of muzzle dark, blackish, and prominent (Figs. 1 and 2).
G. z. zanzibaricus – patch on either side of muzzle less dark, grayish, and less prominent.
G. z. udzungwensis – patch on either side of muzzle less dark, grayish, and less prominent (Figs. 3 and 4).
G. granti – patch on either side of muzzle less dark, grayish, and less prominent (Fig. 5).

Ears
G. cocos – seldom longer than 38 mm, dusky behind.
G. z. zanzibaricus – seldom longer than 35 mm, dusky behind.
G. z. udzungwensis – seldom longer than 33 mm, dusky behind.
G. granti – seldom shorter than 37 mm, blackish behind. Ears not only long but also relatively broad (Fig. 5).

Dorsum
G. cocos – hairs c.10 mm long, tipped buffy-brown (Figs. 1 and 6).
G. z. zanzibaricus – hairs c.8 mm long, tipped cinnamon or rufous-cinnamon (Fig. 7).
G. z. udzungwensis – hairs c.9 mm long, tipped buffy-brown (Figs. 6 and 7).
G. granti – hairs c.12 mm long, tipped buffy-brown with slight pinkish tint (Figs. 5 and 6).

Tail
G. cocos – even length hairs over tail; hairs dense, c.14 mm long, soft. Proximal c.25% of tail same color as dorsum (i.e., buffy-brown); distal c.33% dark buffy-brown in some (Mazeras) specimens, but same color as dorsum in other specimens (Fig. 6).
G. z. zanzibaricus – even length hairs over tail; hairs sparse, c.13 mm long, wiry, rufous-cinnamon, cinnamon, or dusky-cinnamon (highly variable). Tail darker/brighter cinnamon than dorsum, and either evenly colored or with gradual darkening to reddish or dusky toward tip (Fig. 7).
G. z. udzungwensis – even length hairs over tail; hairs sparse, c.11 mm, wiry. Proximal c.75% of tail same color as dorsum (i.e., buffy-brown); distal c.25% slightly darker brown or dusky. Some with tail tipped white (Figs. 4, 6, and 7).
G. granti – bushy, wider over distal c.80%; hairs dense, c.15 mm long, soft. Tail darker than dorsum with distal c.10–60% blackish-brown. Some with tail tipped white (Fig. 6).

Of these four taxa, *G. z. zanzibaricus* and *G. granti* are phenotypically the most distinctive. The dorsum of *G. z. zanzibaricus* is cinnamon and the tail has at least some rufous, whereas the dorsum of the other three taxa is buffy-brown and all lack rufous in the tail (Fig. 7). The color of the dorsum of *G. cocos, G. z. udzungwensis*, and *G. granti* is virtually identical, although there is a slight pinkish tint to the dorsum of *G. granti* when seen in good light (Fig. 6).

When observed at close range in the field, *G. granti* is distinguished from *G. cocos, G. z. zanzibaricus,* and *G. z. udzungwensis* by its relatively large, broad, round, and blackish (behind) ears, and by the very full, bottlebrush-shaped tail, which is blackish-brown over the distal part (Figs. 5 and 6).

The particularly large ears of *G. granti* have been noted previously (for example, Honess 1996; Masters and Bragg 2000).

As a species, *G. zanzibaricus* is probably best distinguished phenotypically from *G. cocos* and *G. granti* by the relatively short, wiry, stiff hairs over the tail. This hair type makes it relatively easy to see the skin of the tail through the pelage (Fig. 4). *Galagoides cocos* and *G. granti* have relatively long, soft, lax hairs over the tail.

Of the four taxa considered here, *G. cocos* and *G. z. udzungwensis* are, phenotypically, the most difficult to distinguish from one another (Fig. 6). The presence in *G. cocos* of a prominent dark, blackish patch on either side of the muzzle is probably the best phenotypic character available for distinguishing *C. cocos* and *G. z. udzungwensis* in the field (Figs. 1–4) (A. Perkin pers. obs.). As already stated, however, all of the characters listed above are in need of detailed quantitative study in order to determine their reliability, both in the field and in the museum.

The penile morphology of *G. cocos*, *G. zanzibaricus*, and *G. granti* is diagnostic (Fig. 12). For details, see Honess (1996), Honess and Bearder (1996), Anderson (2000), and Perkin (in press). See sketches in Kingdon (1997).

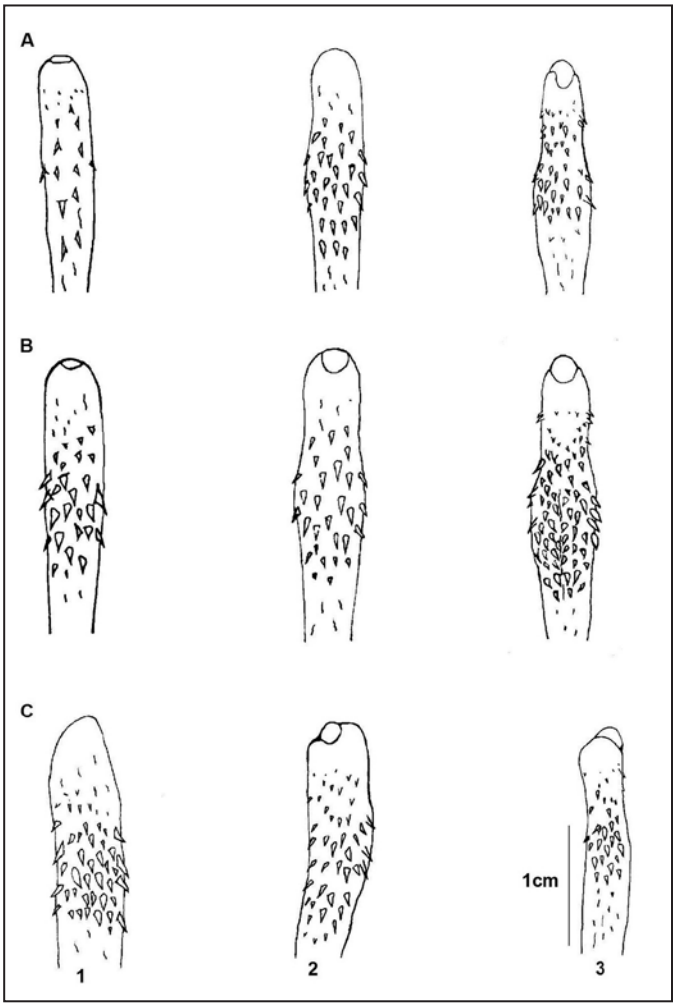

Figure 12. Schematic drawings showing the penile morphology of: 1 – *Galagoides cocos*; 2 – *Galagoides granti*; 3 – *Galagoides zanzibaricus udzungwensis*. A – ventral view; B – dorsal view; C – lateral view (dorsum right). Scale is indicated on the right. See Perkin (in press) for details. Adapted from Perkin (in press).

Vision plays an important role in the life histories of all galagos, perhaps especially for species recognition. Detailed study of the light and dark facial markings of these four taxa may reveal that they are species-specific and, therefore, a useful diagnostic tool. This is not only a priority topic for research related to the search for species-typical differences among *G. cocos*, *G. z. zanzibaricus*, *G. z. udzungwensis*, and *G. granti*, but also among the many other cryptic taxa within the Galagidae (Bearder 1999; Bearder *et al.* 2006).

The differences noted here among *G. cocos, G. zanzibaricus,* and *G. granti* in their species-specific advertising calls, body measurements, and phenotypic characters are consistent with the species-level differences observed for other species in the Galagidae (Honess 1996; Honess and Bearder 1996; Masters and Bragg 2000; Masters and Brothers 2002).

In contrast to the great similarity among *G. cocos*, *G. zanzibaricus*, and *G. granti*, these three species are readily distinguished from the other seven species of galagos with which one or all are sympatric or parapatric. These are *O. garnettii*, the thick-tailed (or large-eared) greater galago (*Otolemur crassicaudatus*), Somali lesser galago (*Galago gallarum*), northern lesser galago (*Galago senegalensis*), southern lesser galago (*Galago moholi*), mountain dwarf galago (*Galagoides orinus*), and Rondo dwarf galago (*Galagoides rondoensis*). The main morphological characters for distinguishing among *G. cocos*, *G. gallarum*, and *G. senegalensis* are summarized in Butynski and De Jong (2004).

Geographic Ranges of *G. cocos, G. zanzibaricus* and *G. granti*

Galagoides cocos occurs in evergreen forest all along the coastal strip (plain) of Kenya, south of the Tana River (Nash *et al*. 1989; Bearder *et al.* 2003; Grubb *et al*. 2003) southward to at least the Mgambo Forest Reserve in northern Tanzania at the north end of the East Usambara Mountains (A. Perkin unpubl. data) (Fig. 13). *Galagoides cocos* is reported to occur as far north as the Webi Shabeelle River in southern Somalia (Nash *et al*. 1989), but this needs confirmation.

Thomas Butynski recorded the advertising call of a galago in the Ololua Forest, Nairobi, that S. Bearder identified as that of the *G. cocos*. Ololua Forest is *c.*390 km inland from the coast of Kenya and, at 1,850 m a.s.l., well above the known altitudinal range for *G. cocos* elsewhere (0–350 m). This record for Ololua Forest requires confirmation.

Galagoides cocos and *G. z. udzungwensis* are parapatric or, perhaps, sympatric at a few sites *c.*2–8 km to the north of the East Usambara Mountains in the coastal strip of northeastern Tanzania (Figs. 13 and 14) (A. Perkin *in litt*. in Grubb *et al*. 2003). Although there is a complex mosaic of habitat types in this region, preliminary observations indicate that *G. cocos* is present in the dry mixed coastal forests and mixed woodland of the northernmost forests of Tanzania's coastal strip (for example, Bombo East I and Bombo East II For-

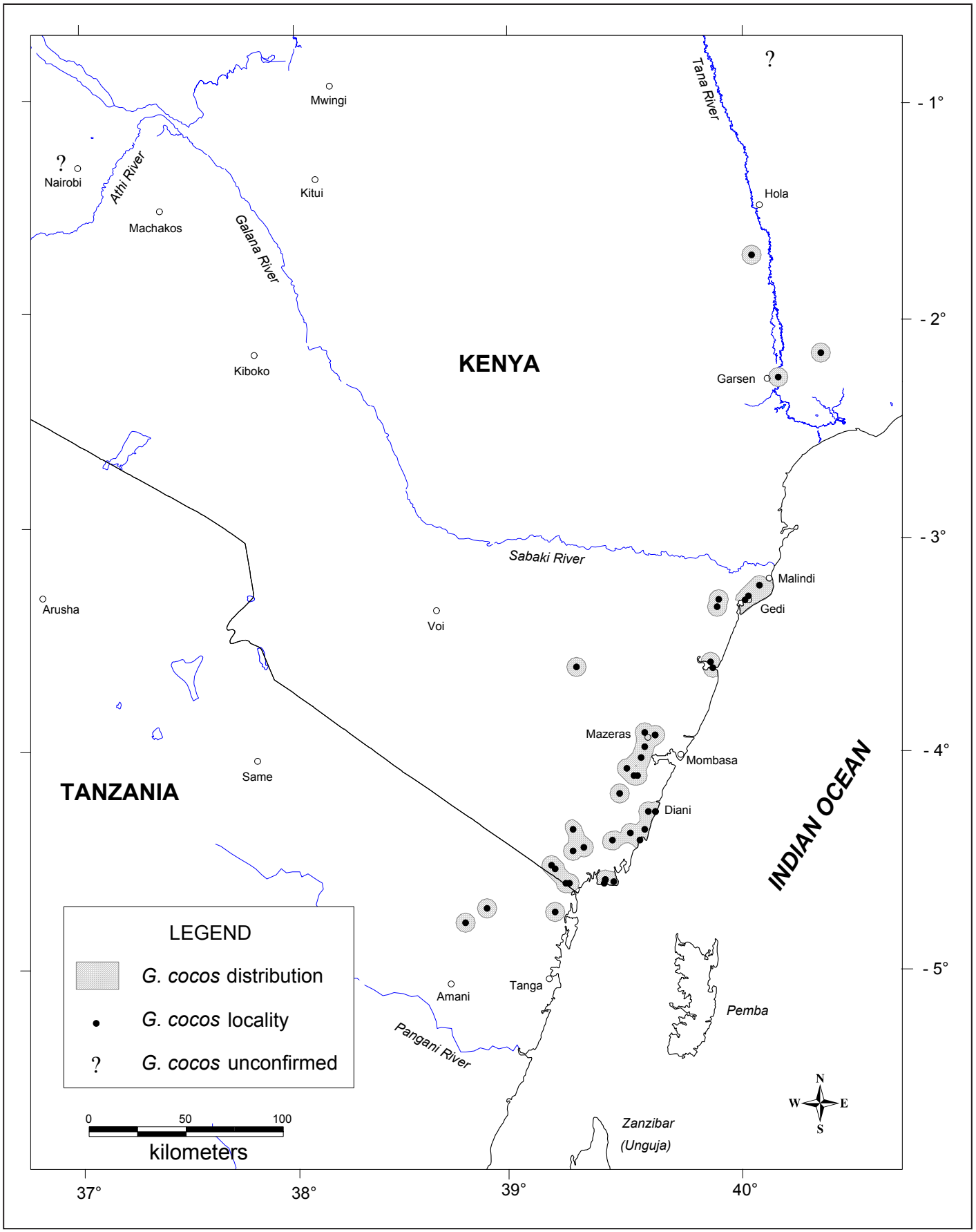

Figure 13. Approximate geographic distribution of the Kenya coast galago (*Galagoides cocos*). The shaded area extends out 5 km from the center of each locality point. The distribution of this species remains poorly known. Names of the sites plotted on this map, and the sources of these data, are available from Yvonne de Jong (e-mail: <yvonne@wildsolutions.nl>).

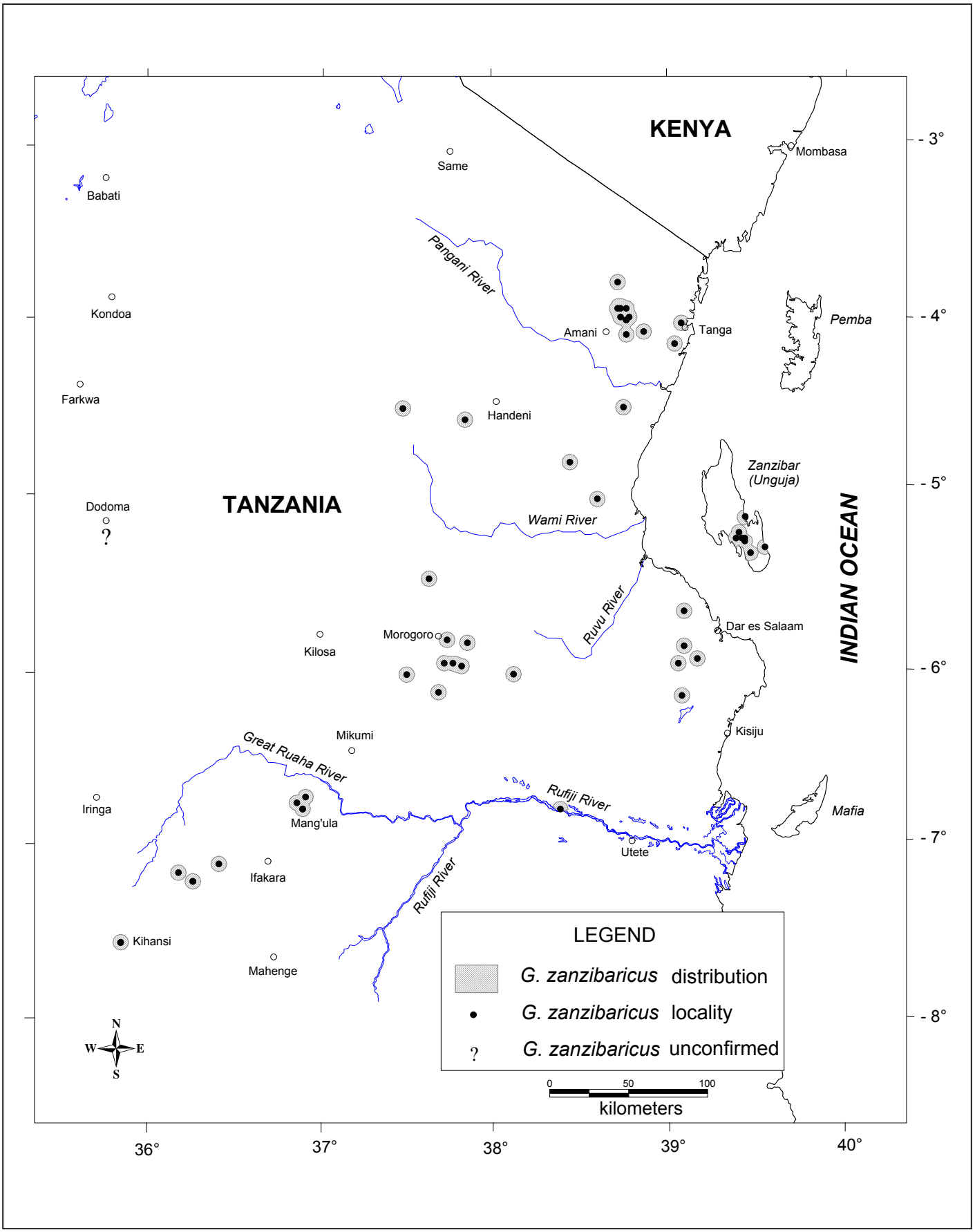

Figure 14. Approximate geographic distributions of the Zanzibar galago (*Galagoides zanzibaricus*) The shaded area extends out 5 km from the center of each locality point. The distribution of this species remains poorly known. Names of the sites plotted on this map, and the sources of these data, are available from Yvonne de Jong (e-mail: <yvonne@wildsolutions.nl>).

est Reserves), as well as in the more moist (but relatively tree-species and bird-species poor) groundwater forests and adjacent woodlands on the lower northern slopes of the East Usambara Mountains (for example, Mgambo Forest Reserve) (A. Perkin and N. Cordeiro unpubl. data). In this region, *G. z. udzungwensis* appears to be confined to the more moist (and relatively tree-species and bird-species rich) forest on the eastern slopes of the East Usambara Mountains (for example, Kambai, Segoma, Manga, and Marimba forest reserves) (A. Perkin unpubl. data).

Galagoides z. udzungwensis and *G. granti* appear to be parapatric at the Kilombero-Rufiji River with *G. z. udzungwensis* reaching its southern limit on the north (left) bank (Fig. 14) and *G. granti* reaching its northern limit on the south (right) bank (Fig. 15) (Honess 1996; A. Perkin *in litt.* in Grubb *et al.* 2003). In addition, the geographic ranges of *G. z. udzungwensis* and *G. granti* either approach one another or meet at the southern end of the Udzungwa Mountains in south-central Tanzania. Here, *G. granti* is present at 1,500 to 1,800 m a.s.l. in the Lulanda Forest Reserve at the headwaters of the Kilombero River (A. Perkin *in litt*. in Grubb *et al*. 2003; A. Perkin unpubl. data), and *G. z. udzungwensis* is present from 400 to 1,070 m a.s.l. at Kihanzi (which is *c*.24 km to the east of Lulanda) (Honess 1996; Butynski *et al*. 1998; N. Cordeiro pers. comm.). Kihanzi is the known southwestern limit for *G. z. udzungwensis*, and Lulanda is the known northwestern limit for *G. granti.*

David Moyer and E. Mulungu (pers. comm.) tape recorded the loud call of a *Galagoides* sp. at three sites in extreme western Tanzania: Mbala Forest, Sitebe-Sifuta Mountains (6º04′40″S, 30º32′10″E, 1,700 m a.s.l., 16 August 2005), Mahale Mountains National Park at Mfitwa Mountain (6º07′55″S, 29º47′38″E, 2,440 m a.s.l., 20 November 2005), and at Pasagulu Mountain (6°03′47″S, 29°45′14″E, 1,500 m a.s.l., 6 February 2006). The species recorded may have been *G. granti*. If so, this extends its geographic range *c*.700 km to the northwest (Fig. 15).

Groves (2001) identified three specimens collected in submontane forest at Bagilo (800–1,000 m a.s.l.) in the Uluguru Mountains (south of Morogoro, Fig. 15) as *G.* cf. *granti* (Grubb *et al*. 2003). If these are *G. granti*, then the Uluguru Mountains represent the northernmost site for this species, and the only known site for *G. granti* that is north of the Rufiji River. These three specimens had earlier been identified by Lawrence and Washburn (1936) as *G. senegalensis zanzibaricus*. A. Perkin has since examined them at Harvard University's Museum of Comparative Zoology (specimen numbers: 22450, 22449, 22451) and also ascribes them to *G. zanzibaricus*. In 1993, P. E. Honess and S. K. Bearder (Honess 1996) visited the forest at Bagilo but did not find *G. granti* there — only *G. orinus* was present. Unfortunately, there is no longer any forest at Bagilo (Perkin 2000; Doggart *et al*. 2004) but A. Perkin (unpubl. data) found *G. zanzibaricus* at 900 m a.s.l. on the edge of the Uluguru North Forest Reserve (*c*.2 km west of Bagilo Village) and up to 700 m a.s.l. in the Uluguru Mountains.

The known southern limit for *G. granti* is the Limpopo River in southern Mozambique. The western limit in the southern part of the range appears to be extreme eastern Zimbabwe (Smithers and Lobão Tello 1976; Smithers and Wilson 1979; Skinner and Smithers 1990).

In summary, present information indicates that *G. cocos*, *G. zanzibaricus*, and *G. granti* are parapatric, or narrowly sympatric, species of the evergreen forests of the coastal strip of eastern Africa from northern Kenya (perhaps southern Somalia) to extreme southern Mozambique and extreme eastern Zimbabwe. *Galagoides cocos* is the northern species, *G. zanzibaricus* is the central species, and *G. granti* is the southern species.

Conservation Status of *G. cocos*, *G. zanzibaricus,* and *G. granti*

Galagoides cocos, G. zanzibaricus, and *G. granti* now survive in highly fragmented, probably declining, populations as a result of the extensive (>65%) loss of eastern Africa's original coastal forest cover. More than 90% of the original coastal forest of Kenya and Tanzania has either been destroyed or degraded (Burgess *et al*. 2004). Fortunately, all three species are able to persist in secondary forest and in mosaics of mixed agriculture where some forest remains.

As a recently resurrected species (Grubb *et al*. 2003), *G. cocos* does not yet appear on the IUCN Red List. It is the most abundant and widespread galago in the coastal forests of Kenya, with densities of approximately 170–180 individuals/km² both at Gedi and Diani (Harcourt and Nash 1986a). *Galagoides cocos* is found at elevations from sea level to at least 210 m a.s.l. over the coastal zone of Kenya (T. Butynski and Y. de Jong unpubl. data), and to at least 350 m a.s.l. in the foothills of the East Usambara Mountains, Tanzania (A. Perkin unpubl. data). The information available indicates that *G. cocos*, when assessed for the IUCN Red List using the 2001 criteria (IUCN 2001), will be placed in the Least Concern category.

G. zanzibaricus is listed as Lower Risk/Near Threatened on the *2006 IUCN Red List* (IUCN 2006), but assessed only using the 1994 criteria (IUCN 1994). *G. zanzibaricus* is the most abundant and widespread galago in the coastal forests of Tanzania, including 'coastal' forest sites located at least 370 km inland (for example, Udzungwa Mountains) to *c*.1,100 m a.s.l. The density of *G. zanzibaricus* varies greatly from site to site. In the Udzungwa Mountains (for example, Matundu Forest Reserve), *G. z. udzungwensis* is estimated to occur at densities of more than 500 individuals/km² (Butynski *et al*. 1998), whereas <100 individuals/km² occur at many other sites (T. Butynski and A. Perkin pers. obs.). Although *G. z. zanzibaricus* is confined to Unguja Island, it is widespread over the eastern and southern parts of the island (Lumsden and Masters 2001), and is common in at least some places (e.g., >200 individuals/km² in Jozani–Chwaka Bay National Park (T. Butynski and Y. de Jong pers. obs). The information available indicates that *G. zanzibaricus*, when reassessed for the IUCN Red List, should be placed in the 'Least Concern' category.

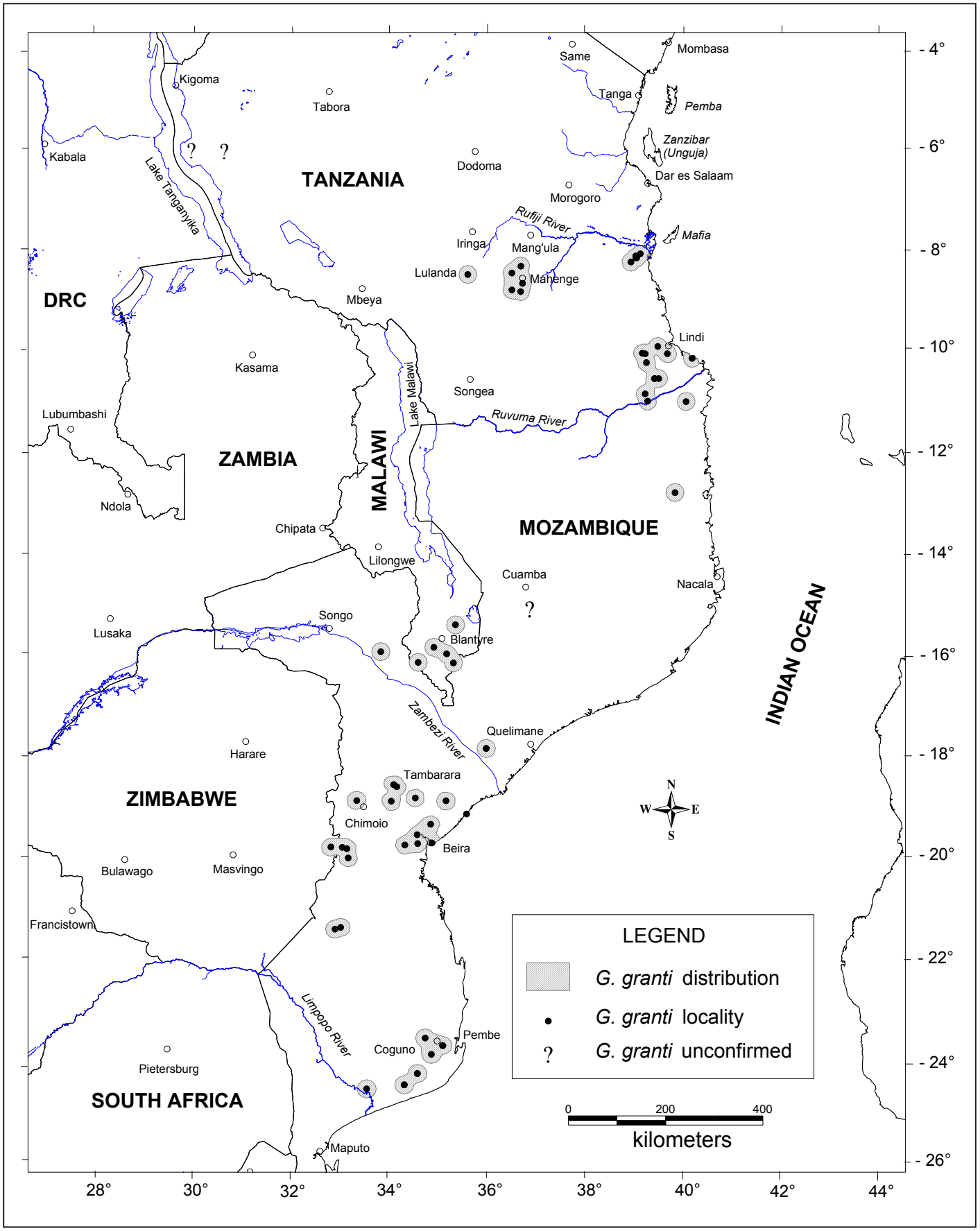

Figure 15. Approximate geographic distributions of the Mozambique galago (*Galagoides granti*). The shaded area extends out 20 km from the center of each locality point. The distribution of this species remains poorly known. Names of the sites plotted on this map, and the sources of these data, are available from Yvonne de Jong (e-mail: <yvonne@wildsolutions.nl>).

The two subspecies, *G. z. zanzibaricus* and *G. z. udzungwensis,* have not as yet been assessed for the IUCN Red List. While *G. z. udzungwensis* is a widespread subspecies that will likely be assessed as Least Concern, *G. z. zanzibaricus* has a far smaller 'extent of occurrence', being endemic to Unguja Island, Zanzibar (*c*.2,000 km²) where rates of habitat degradation, loss, and fragmentation are particularly high. As such, *G. z. zanzibaricus* is expected to be assessed as an Endangered taxon.

Galagoides granti, assessed under the 1994 criteria (IUCN 1994), is listed as Data Deficient in the *2006 IUCN Red List* (IUCN 2006). *Galagoides granti* is present in coastal and submontane evergreen forest, gallery forest, and species-rich woodlands, including some hilly miombo woodlands (e.g., Mahenge foothills). In the southern part of its range, *G. granti* is present between the coast and about 200 km inland (i.e., eastern Zimbabwe) up to 360 m a.s.l. (Smithers and Wilson 1979; Skinner and Smithers 1990). According to the specimen tags, C. H. B. Grant collected this species up to 400 m a.s.l. at Tambarara in central Mozambique. In the northern part of its range, *G. granti* occurs from the coast to at least 310 km inland (i.e., Lulanda, Tanzania) up to at least 1,800 m a.s.l. *Galagoides granti* occurs over a much greater range of habitat types, altitudes, and climates than does *G. cocos* or *G. zanzibaricus*. There is now enough information available for an IUCN Red List assessment of this species. The available data indicate that *G. granti*, once reassessed, will be placed in the Least Concern category. *Galagoides cocos, G. zanzibaricus,* and *G. granti* are all currently CITES Appendix II species (http://www.cites.org).

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Literature Cited

Allen, G. M. 1939. A checklist of African mammals. *Bull. Mus. Comp. Zool. Harvard College* 83: 1–763.

Allen, G. M. and A. Loveridge. 1927. Mammals from the Uluguru and Usambara Mountains, Tanganyika Territory. *Proc. Boston Soc. Nat. Hist.* 38: 425–426.

Ambrose, L. 1999. Species diversity in West and Central African galagos (Primates, Galagonidae): The use of acoustic analysis. PhD thesis, Oxford Brookes University, Oxford.

Ambrose, L. 2003. Three acoustic forms of Allen's galagos (Primates: Galagonidae) in the Central African region. *Primates* 44: 25–39.

Anderson, M. J. 1999. The use of hand morphology in the taxonomy of galagos. *Primates* 40: 469–478.

Anderson, M. J. 2000. Penile morphology and classification of bush babies (subfamily Galagoninae). *Int. J. Primatol.* 21: 815–836.

Bearder, S. K. 1999. Physical and social diversity among nocturnal primates: A new view based on long-term research. *Primates* 40: 267–282.

Bearder, S. K., P. E. Honess and L. Ambrose. 1995. Species diversity among galagos with special reference to mate recognition. In: *Creatures of the Dark: The Nocturnal Prosimians*, L. Alterman, G. A. Doyle and M. K. Izard (eds.), pp.331–352. Plenum Press, New York.

Bearder, S., L. Ambrose, C. Harcourt, P. Honess, A. Perkin, E. Pimley, S. Pullen and N. Svoboda. 2003. Species-typical patterns of infant contact, sleeping site use and social cohesion among nocturnal primates in Africa. *Folia Primatol.* 74: 337–354.

Bearder, S. K., K. A. I. Nekaris and D. J. Curtis. 2006. A re-evaluation of the role of vision in the activity and communication of nocturnal primates. *Folia Primatol*. 77: 50–71.

Burgess, N, J. Salehe, N. Doggart, G. P. Clark, I. Gordon, P. Sumbi and A. Rodgers. 2004. Coastal forests of eastern Africa. In: *Hotspots Revisited*, R. A. Mittermeier, P. Robles Gil, M. Hoffmann, J. Pilgrim, T. Brooks, C. G. Mittermeier, J. Lamoreux and G. A. B. da Fonseca (eds.), pp.230–239. CEMEX, Agrupación Serra Madre, SC, México.

Butynski, T. M., C. L. Ehardt and T. T. Struhsaker. 1998. Notes on two dwarf galagos (*Galagoides udzungwensis* and *Galagoides orinus*) in the Udzungwa Mountains, Tanzania. *Primate Conserv.* (18): 69–75.

Butynski, T. M. and Y. A. de Jong. 2004. Natural history of the Somali lesser galago (*Galago gallarum*). *J. E. Afr. Nat. Hist.* 93: 24–38.

Courtenay, D. O. and S. K. Bearder. 1989. The taxonomic status and distribution of bushbabies in Malawi with emphasis on the significance of vocalizations. *Int. J. Primatol.* 10: 17–34.

DelPero, M., J. C. Masters, D. Zuccon, P. Cervella, S. Crovella and G. Ardito. 2000. Mitochondrial sequences as

indicators of generic classification in bush babies. *Int. J. Primatol.* 21: 889–904.

Doggart, N., J. Lovett, B. Mhoro, J. Kiure, A. Perkin and N. D. Burgess. 2004. Biodiversity surveys in the forest reserves of the Uluguru Mountains: Descriptions of the biodiversity of individual forest reserves. Report, Tanzania Forest Conservation Group, Dar es Salaam, Tanzania.

Elliot, D.G. 1913. *A Review of the Primates*. Vol. 3. American Museum of Natural History, New York.

Groves, C. P. 1977. Taxonomy and phylogeny of prosimians. In: *Prosimian Anatomy, Biochemistry and Evolution*, R. D. Martin, G. A. Doyle and A. C. Walker (eds), pp.449–473. Duckworth, London.

Groves, C. P. 1993. Order Primates. In: *Mammal Species of the World: A Taxonomic and Geographic Reference*, 2nd Ed., D. E. Wilson and D. M. Reeder (eds.), pp.243–277. Smithsonian Institution Press, Washington, DC.

Groves, C. P. 2001. *Primate Taxonomy*. Smithsonian Institution Press, Washington, DC.

Groves, C. P. 2005. Order Primates. In: *Mammal Species of the World: A Taxonomic and Geographic Reference*, 3rd edi. D. E. Wilson and D. M. Reeder (eds.), pp.111–184.. Johns Hopkins University Press, Baltimore, Maryland.

Grubb, P., T. M. Butynski, J. F. Oates, S. K. Bearder, T. R. Disotell, C. P. Groves and T. T. Struhsaker. 2003. Assessment of the diversity of African primates. *Int. J. Primatol.* 24: 1301–1357.

Harcourt, C. S. 1984. The behaviour and ecology of galagos in Kenyan coastal forest. PhD thesis, University of Cambridge, Cambridge, UK.

Harcourt, C. S. 1986. *Galago zanzibaricus*: Birth seasonality, litter size and perinatal behaviour of females. *J. Zool., Lond.* 210: 451–457.

Harcourt, C. S. and S. K. Bearder. 1989. A comparison of *Galago moholi* in South Africa with *Galago zanzibaricus* in Kenya. *Int. J. Primatol.* 10: 35–45.

Harcourt, C. S. and L. T. Nash. 1986a. Species differences in substrate use and diet between sympatric galagos in two Kenyan coastal forests. *Primates* 27: 41–52.

Harcourt, C. S. and L. T. Nash 1986b. Social organization of galagos in Kenyan coastal forests. 1. *Galago zanzibaricus*. *Am. J. Primatol.* 10: 339–355.

Heller, E. 1912. New races of insectivores, bats, and lemurs from British East Africa. *Smithson. Misc. Coll.* 60: 1–13.

Hill, W. C. O. 1953. *Primates: Comparative Anatomy and Taxonomy. I. Strepsirhini.* University of Edinburgh Press, Edinburgh, UK.

Hill, W. C. O. and J. Meester. 1977. Suborder Prosimii, Infraorder Lorisformes. In: *The Mammals of Africa: An Identification Manual*, Part 3.2., J. Meester and H. W. Setzer (eds.). Smithsonian Institution Press, Washington, DC.

Hollister, N. 1924. East African mammals in the United States National Museum. Part III. Primates, Artiodactyla, Proboscidea, and Hyracoidea. *Bull. U. S. Natl. Mus.* 99: 1–164.

Honess, P. E. 1996. Speciation among galagos (Primates: Galagidae) in Tanzanian forests. PhD Thesis, Oxford Brookes University, Oxford, UK.

Honess, P. E. and S. K. Bearder. 1996. Descriptions of the dwarf galago species of Tanzania. *African Primates* 2: 75–79.

IUCN. 1994. *IUCN Red List Categories*. IUCN Species Survival Commission, Gland, Switzerland.

IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission, Gland, Switzerland.

IUCN. 2006. *2006 IUCN Red List of Threatened Species.* Website: www.iucnredlist.org. Accessed 15 May 2006.

Jenkins, P. D. 1987. *Catalogue of Primates in the British Museum (Natural History) and Elsewhere in the British Isles. Part IV. Suborder Strepsirrhini, Including the Subfossil Madagascan Lemurs and Family Tarsiidae.* British Museum (Natural History), London.

Kingdon, J. 1971. *East African Mammals*. Vol. 1. Academic Press, London.

Kingdon, J. 1997. *The Kingdon Field Guide to African Mammals*. Academic Press, London.

Lawrence, B. and S. L. Washburn. 1936. A new eastern race of *Galago demidovii*. *Occ. Pap. Boston Soc. Nat. Hist.* 8: 255–266.

Lumsden, W. H. R. and J. C. Masters. 2001. Galago (Galagonidae) collections in East Africa (1953–1955): Ecology of the study areas. *African Primates* 5: 37–42.

Masters, J. C. 1991. Loud calls of *Galago crassicaudatus* and *G. garnettii* and their relation to habitat structure. *Primates* 32: 149–174.

Masters, J. C. 1998. Speciation in the lesser galagos. *Folia Primatol.* 69(Suppl.1): 357–370.

Masters, J. C. and N. P. Bragg. 2000. Morphological correlates of speciation in bush babies. *Int. J. Primatol.* 21: 793–813.

Masters, J. C. and D. J. Brothers. 2002. Lack of congruence between morphological and molecular data in reconstructing the phylogeny of the Galagonidae. *Am. J. Phys. Anthropol.* 117: 79–93.

Nash, L. T., S. K. Bearder and T. R. Olson. 1989. Synopsis of galago species characteristics. *Int. J. Primatol.* 10: 57–80.

Perkin, A. W. 2000. The taxonomic status of bushbabies (galagos) in the Uluguru Mountains. Report for the Wildlife Conservation Society of Tanzania, Dar es Salaam. Webpage: www.africanconservation.com/uluguru. Accessed 8 May 2006.

Perkin, A. W. In press. Comparative penile morphology of East African galagos of the genus *Galagoides* (Family Galagidae): Implications for taxonomy. *Int. J. Primatol.*

Perkin, A. W., S. K. Bearder, T. M. Butynski, B. Agwanda and B. Bytebier. 2002. The Taita mountain dwarf galago *Galagoides* sp.: A new primate for Kenya. *J. E. Afr. Nat. Hist.* 91: 1–13.

Schwarz, E. 1931. On the African long-tailed lemurs or galagos. *Ann. Mag. Nat. Hist.* 7: 41–66.

Skinner, J. D. and R. H. N. Smithers. 1990. *The Mammals of the Southern African Subregion*. University of Pretoria, Pretoria.

Smithers, R. H. N. and J. L. P. Lobão Tello. 1976. Check list and atlas of the mammals of Mocambique. *Museum Memoir, Natl. Museums and Monuments of Rhodesia* No. 8.

Smithers, R. H. N. and V. J. Wilson. 1979. Check list and atlas of the mammals of Zimbabwe Rhodesia. *Museum Memoir, Natl. Museums and Monuments of Rhodesia* No. 9.

Zimmermann, E. 1990. Differentiation of vocalisations in bushbabies (Galaginae, Prosimiae, Primates) and the significance for assessing phylogenetic relationships. *Z. Zoologische Systematik und Evolutionsforschung* 28: 217–239.

Zimmermann, E., S. K. Bearder, G. A. Doyle and A. B. Andersson. 1988. Variations in vocal patterns of lesser bushbabies (*Galago senegalensis* and *Galago moholi*) and their implications for taxonomic relationships. *Folia Primatol.* 51: 87–105.

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Appendix I

Body measurements for adults of the Kenya coast galago (*Galagoides cocos*), the Zanzibar galago (*Galagoides zanzibaricus*), and the Mozambique (galago (*Galagoides granti*). All measurements are either known to be, or believed to be, from living or fresh adult specimens.

Table A. Measurements for eight *Galagoides cocos* collected at Mazeras, Kenya, the type locality for *G. cocos* (Hollister 1924). All measurements taken from the tags of specimens collected by E. Heller and housed at the United States National Museum (specimen numbers: 181810, 184218, 184219, 184220, 184221, 184222, 184223, and 184225). Because adult male and adult female body linear measurements for *G. cocos* are not significantly different (Harcourt and Nash 1986b), the data for males and females are combined in this sample.

Measurement	Mean	SD	Range	Sample size (n)
Head+body length	155 mm	6	145–165 mm	8
Tail length	213 mm	11	200–230 mm	8
Hindfoot length	57 mm	3	53–60 mm	7
Ear length	35 mm	2	33–38 mm	7

Table B. Measurements for live specimens of *Galagoides cocos*. These data derive from the following two sources: (1) Harcourt and Nash (1986b) for *G. cocos* at Gedi (*c.*100 km northeast of Mombasa) and Diani (30 km south of Mombasa) on the coast of Kenya; (2) A. Perkin (unpubl. data) for *G. cocos* at Arabuko-Sokoke Forest (*c.*100 km northeast of Mombasa, n = 2), Diani (n = 3), and East Usambara Mountains (*c.*150 km southwest of Mombasa (n = 1). Because adult male and adult female body linear measurements for *G. cocos* are not significantly different, the data for males and females are combined in this sample (Harcourt and Nash 1986b). Because body weights of adult male and adult (non-pregnant) female *G. cocos* are significantly different (Harcourt and Nash 1986b), the body weight data are presented separately for each sex.

Measurement	Mean	Range	Sample size (n)
Head + body length	159 mm	142–183 mm	38
Tail length	212 mm	182–230 mm	30
Hindfoot length	54 mm	40–57 mm	49
Ear length	30 mm	23–40 mm	32
Body weight (males)	150 g	135–167 g	36
Body weight (females)	138 g	117–172 g	42

Table C. Combined measurements for male and female *Galagoides zanzibaricus zanzibaricus* from Unguja Island, Zanzibar, Tanzania, the type locality for *G. zanzibaricus*. Measurements taken from one specimen captured and released by A. Perkin and from the tags of 10 specimens housed at the British Museum of Natural History. Nine of these collected by W. H. R. Lumsden (specimen numbers 1964.971, 1964.972, 1964.974, 1964.975, 1964.977, 1964.978, 1964.979, 1964.980, and 1964.981) and one obtained by an unknown collector (specimen number: 1955.331).

Measurement	Mean	SD	Range	Sample size (n)
Head+body length	143 mm	8	125–150 mm	11
Tail length	214 mm	12	198–235 mm	11
Hindfoot length	56 mm	3	51–59 mm	11
Ear length	32 mm	2	30–35 mm	11
Body weight	127 g	20	104–172 g	10

Table D. Combined measurements for male and female *Galagoides zanzibaricus udzungwensis* obtained from the following sites in Tanzania; two from Matundu Forest Reserve (Honess 1996); two from Kissarawe (housed at the British Museum of Natural History); two from Pugu Forest Reserve, three from Pande Game Reserve (A. Perkin, unpubl. data); four from Bagilo, Uluguru Mountains; and four from Amboni, near Tanga. These last eight specimens were collected by A. Loveridge and are housed at the Museum of Comparative Zoology, Harvard University.

Measurement	Mean	SD	Range	Sample size (n)
Head+body length	162 mm	11	139–180 mm	17
Tail length	222 mm	16	202–270 mm	17
Hindfoot length	58 mm	6	50–70 mm	17
Ear length	31 mm	3	25–37 mm	17
Body weight	145 g	27	118–195 g	6

Table E. Combined measurements for male and female *Galagoides granti* collected at Coguno (type locality) and Tambarara, Mozambique, by C. H. B. Grant during the Rudd Expedition. Coguno is the type locality. Measurements taken from specimen tags. All 12 specimens housed at the British Museum of Natural History (specimen numbers: 906.11.8.5, 1906.11.8.6, 1906.11.8.7, 1906.11.8.8, 1906.11.8.9, 1906.11.8.10, 1908.1.1.12, 1908.1.1.13, 1908.1.1.14, 1908.1.1.15, 1908.1.1.16, and 1908.1.1.129).

Measurement	Mean	SD	Range	Sample size (n)
Head+body length	153 mm	6	140–160 mm	12
Tail length	230 mm	6	216–237 mm	12
Hindfoot length	58 mm	3	54–63 mm	12
Ear length	38 mm	2	36–43 mm	12

Table F. Combined measurements for male and female *Galagoides granti* from eastern Zimbabwe (Smithers & Wilson 1979).

Measurement	Mean	Range	Sample size (n)
Head+body length	162 mm	Not provided	10
Tail length	232 mm	214–254 mm	10
Hindfoot length	62 mm	59–63 mm	10
Ear length	40 mm	38–41 mm	9
Weight	165 g	139–178 mm	6

Table G. Combined measurements for two male and one female *Galagoides granti* from Tanzania, two from Kichi Hills Forest Reserve, and one from Lulunda, Udzungwa Mountains (A. Perkin unpubl. data).

Measurement	Mean	SD	Range	Sample size (n)
Head+body length	164 mm	15	154–181 mm	3
Tail length	214 mm	7	208–222 mm	3
Hindfoot length	58 mm	1	58–59 mm	3
Ear length	38 mm	1	37–38 mm	2
Body weight	136 g	25	110–160 g	3