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DESCRIPTIONS OF THE DWARF GALAGO SPECIES OF TANZANIA

Abstract: Based on field research in Tanzania (1992–1995) (Honess, 1996), this paper describes two new species of galago and elevates two other galagos from subspecies to species. These four new species are established on the basis of species-specific vocalisations, reproductive morphology and body measurements.

Résumé: Basé sur une recherche effectuée sur le terrain en Tanzanie (1992–1995) (Honess, 1996), le document décrit deux nouvelles espèces de galago et a promu deux autres galagos, qui étaient jusq'à lors des sous-espèces, au niveau d'espèce. L'établissement de les quatre nouvelles espèces est basé sur le espèces-spécifiques vocalisations, la morphologie reproductrice ainsi que les dimensions corporelles.

Introduction

A study of galagos (Primates: Galagonidae (Olson, 1979)) in Tanzania (1992–1995) located populations of unknown taxonomic identity. Further research determined that two of these represent new species, while two others, previously classified as *Galagoides zanzibaricus granti* and *Galagoides demidoff orinus*, required elevation to full specific status (Honess, 1996). Kingdon (1997) published the two new species in a manner which formalises Honess as their author. This paper justifies these taxonomic changes in detail. Marked behavioural differences, especially in vocalisations, illustrate the taxonomic distinctiveness of these new species. This is confirmed by independent measures of

morphological differences in comparison with well established species.

Several researchers show a strong link between differences in the taxonomic status of galagos and both their vocal profile (all loud calls in the vocal repertoire) (Bearder *et al.*, 1995) and main advertisement calls (Courtenay & Bearder, 1989; Zimmermann, 1990; Bearder *et al.*, 1995). Special consideration is given to advertisement calls because their primary functions of attracting companions and repelling rivals are of key importance to the Specific Mate Recognition System (Paterson, 1985). They are often the most frequently heard calls and may provide the most rapid assessment of species identity during surveys.

The taxonomic relevance of differences in penile morphology has been demonstrated for galagos (Dixson & Van Horn, 1977; Dixson, 1989) and for primates in general (Dixson, 1987). Considerable differences are seen in the overall shape of the penis, and in the presence or absence and arrangement of penile spines.

At the start of this study a review of the group (Nash *et al.*, 1989) identified 11 species of galagos in three genera: *Otolemur crassicaudatus* and *O. garnettii*; *Galago senegalensis*, *G. gallarum*, *G. moholi*, *G. elegantulus* and *G. matschiei*; *Galagoides demidoff*, *G. thomasi*, *G. zanzibaricus* and *G. alleni*.

New Taxa Identified Within the Family Galagonidae

Galagoides demidoff orinus and *Galagoides zanzibaricus granti* can be elevated to the full species status of *Galagoides orinus* and *Galagoides granti*, respectively, on the basis of comparison with *G. demidoff demidoff* and *G. zanzibaricus zanzibaricus*, respectively. The differences observed are consistent with species level differences illustrated for other galago taxa (Honess, 1996). These differences include those observed in species-specific vocalisations and penile morphology (Honess, 1996) and in body measurements (see Tables 1 & 2). Neither of the two new species described by Honess (1996), below and published in Kingdon (1997) appear in any previous classification.

Table 1. Comparison of the body weight and length measurements of galagos described in the text (data ranges and standard deviations were generally not available from sources). Sources: (1) Jenkins (1987); (2) Honess (1996); (3) Olson (unpubl. data); (4) Honess (unpubl. data).

Species	Body weight (g)	Head-body length (mm)	Tail length (mm)	Hindfoot length (mm)	Ear length (mm)
<i>G. granti</i> (1)	134 (n=5)	155 (n=17)	226 (n=17)	57 (n=17)	36.6 (n=17)
<i>G. udzungwensis</i> (2)	135.5 (n=2)	147 (n=3)	230 (n=3)	61.5 (n=3)	28 (n=3)
<i>G. rondoensis</i> (2)	59.8 (n=5)	107 (n=7)	183.6 (n=8)	44.9 (n=8)	27.7 (n=7)
<i>G. d. demidoff</i> (3)	72 (n=40)	130.2 (n=69)	180.9 (n=69)	46.3 (n=68)	23.7 (n=67)
<i>G. z. zanzibaricus</i> (3)	150.8 (n=21)	155 (n=47)	221.7 (n=47)	58.1 (n=45)	36.7 (n=46)
<i>G. orinus</i> (4)	N/A	155 (n=1)	180 (n=1)	47.7 (n=1)	25 (n=1)

Table 2. Comparison of the cranial dimensions (mm) of type specimens of the species of galago described in the text together with figures for *G. d. demidoff* and *G. z. zanzibaricus*. Sources: (1) Thomas & Wroughton (1906); (2) Honess (1996); (3) Olson (unpubl. data); (4) Lawrence and Washburn (1936).

Species	Greatest length	Basal length	Zygomatic breadth	Mastoid breadth	Brain case height	Palate length	Front canine to back of m ³ (upper)
<i>G. granti</i> (1)	45	35	28	23.5	—	18+	15.6
<i>G. udzungwensis</i> (2)	41.9	—	26.7	22.5	16	—	15
<i>G. rondoensis</i> (2)	35.5	—	20.2	18.5	14	—	12
<i>G. d. demidoff</i> (3)	34.3	25.3	22.2	—	16.3	12.0	—
	(n=105)	(n=105)	(n=105)		(n=105)	(n=106)	
<i>G. z. zanzibaricus</i> (3)	40.7	30.7	26.5	—	18.7	14.9	—
	(n=55)	(n=55)	(n=54)		(n=54)	(n=57)	
<i>G. orinus</i> (4)	39.2	27.4	—	18.9	—	14.0	13.7

Each species is described separately. The formal details of the species are given first, followed by the diagnosis and details of the species' behaviour and morphology that illustrate their distinct identity.

Genus: *Galagoides* A. Smith, 1833

The Matundu Galago

Species: *Galagoides udzungwensis* Honess, 1997.

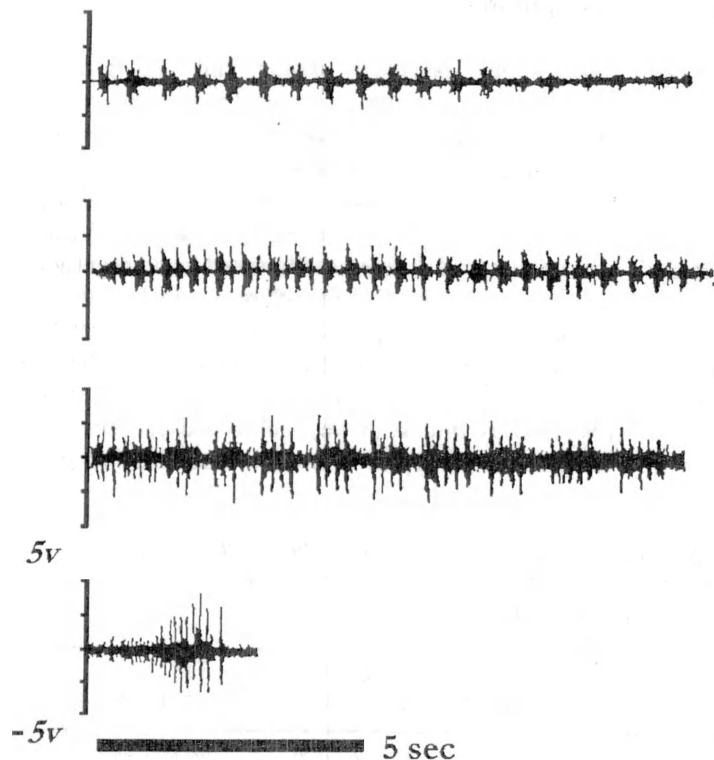


Figure 1. Comparison of oscillograms of the advertisement calls of four species of galagos (top to bottom): *Galagoides udzungwensis*, *G. rondoensis*, *G. granti*, and *G. demidoff*.

1997 *Galagoides udzungwensis* Honess, in Kingdon, *The Kingdon Field Guide to African Mammals*, pp. 106–107.

This species is named after the Udzungwa Mountains, the area of the type locality. The common name is after the forest reserve where the species was first identified.

Taxonomic Note: This species is placed in the genus *Galagoides* based on cranial similarities to established species in that genus (P. Jerkins, pers. comm.). A second specimen (M.707) exists at The Zoological Museum, Copenhagen, Denmark.

Holotype: Male (full wet specimen) ZD.95.251, Natural History Museum, London.

Type Locality: Ichima, Kilombero District, Morogoro Region, Tanzania (8°01'S, 36°31'E).

Distribution: Known from lowland forest on the eastern side of Udzungwa (as above), Uluguru (7°00'S, 37°45'E) and East Usambara Mountains (10°07'S, 37°30'E), Tanzania (Honess, 1996).

Diagnosis: Of similar body size, *G. udzungwensis* can be distinguished from *Galagoides granti* by its shorter ears. In contrast to *G. granti*, the tail has no blackish brown tip, though it is marginally darker distally than the greyish-brown of the rest of the tail. In *G. granti* the tail is unusually long, bushy and long-haired (20–25 mm) (Thomas & Wroughton, 1906), whereas in *G. udzungwensis*, although similarly very long, it is more sparsely covered with shorter hairs. The orbital rings present in *G. granti*

are absent or very weak in *G. udzungwensis*. Another distinguishing feature is the hind foot of *G. udzungwensis*, which is larger than that of *G. granti* (Table 1). The skull measurements of ZD.95.251 and M.707 show greatest similarity to *G. granti*, from which

Individual hairs are grey at the base, buffy-brown towards the tip, with a very dark tip. Ventrum: Yellowish-buff (mainly anterior). Individual hairs are grey at the base with buff tips. Dorsal colour grades into ventral without any demarcation. Face: Broad white

Table 3. Results of an analysis of variance of two advertisement call parameters for *G. granti* (G.g.), *G. udzungwensis* (G.u.) and *G. rondoensis* (G.r.).

Parameter	Species	Sample size	Mean (ms)	F	P
Unit interval	G.g./G.u.	41 / 181	548.2 / 284.4	353.98	<0.001 ***
	G.u./G.r.	181 / 310	284.4 / 200.9	140.55	<0.001 ***
	G.r./G.g.	310 / 41	200.9 / 548.2	471.98	<0.001 ***
Unit length	G.g./G.u.	53 / 196	413.4 / 220.0	240.41	<0.001 ***
	G.u./G.r.	196 / 345	220.0 / 386.0	485.08	<0.001 ***
	G.r./G.g.	345 / 53	386.0 / 413.4	2.72	<0.100 ns

G. udzungwensis is easily distinguished on distribution, pelage, anatomical and behavioural features. The vocal profile, especially advertisement calls, are extremely different between these species (Honest, 1996).

Species' Characteristics

Vocalisations: The vocal profile and structure of the advertisement call (double unit rolling call; Fig. 1) of *G. udzungwensis* differ from all other known galago species (Bearder *et al.*, 1995). The most meaningful comparison of advertisement calls, to obtain equivalent measurements, is between those with similar structures. An analysis of variance was carried out to discriminate between the three most similar species: *G. granti*, *G. udzungwensis* and *G. rondoensis* (Table 3).

Penile Morphology: *G. udzungwensis* differs in its penile morphology from *G. rondoensis*, *G. granti* and all other species for which penile morphology has been noted (Fig. 2) (Honest, 1996).

Pelage (Honest, 1996): Dorsum: Grey-brown.

stripe extends from the base of the rhinarium to just posterior to the eyes. No distinct eye-rings. Yellowish-buff cheeks. Orange-buff extends on the throat, underside of the head. Tail: Greyish-brown, darker distally (the last third). Of uniform thickness with fur sparse enough to see through to the skin.

Cranial dimensions: see Table 2.

The Rondo Galago

Species: *Galagoides rondoensis* Honest, 1997. 1997 *Galagoides rondoensis* Honest, in Kingdon, *The Kingdon Field Guide to African Mammals*, p.106.

This species is named after Rondo Forest Reserve, the type locality.

Taxonomic note: The name *Galagoides demidoff rondoensis* appears in Rowe (1996), where it is a *nomen nudum*. Rowe (1996) does not provide a description; the name was mistakenly referenced to Groves (1989), which does not contain a description, or even the name,

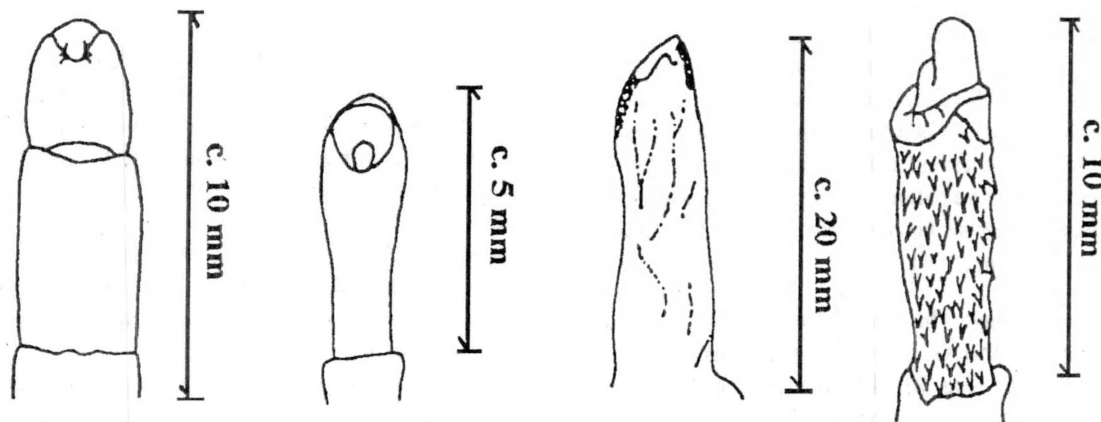


Figure 2. Comparison of penile morphology of four species of galagos (left to right): *Galagoides udzungwensis*, *G. rondoensis*, *G. granti* and *G. demidoff*.

of this taxon.

Galagoides rondoensis is clearly congeneric with *G. demidoff* to which species the late R.W. Hayman ascribed them on NHM labels (P.D. Jenkins, in litt.).

Five specimens (ZD.1954.746–749 and ZD.1964.1970) of this species exist in the Natural History Museum, London. The presence of adult dentition (and in one case, two foetuses), rule them out as infants or juveniles of larger animals. The nominated holotype was chosen as it is from Rondo where considerable behavioural data have been collected.

Holotype: Adult female No. ZD.1964.1970 (skin and skull); Natural History Museum, London.

Type locality: Rondo Forest Reserve, Lindi District, Lindi Region, Tanzania (10°07'S, 39°23'E).

Distribution: Known from two forest reserves in Lindi District: Rondo (as above) and Litipo (10°02'S, 39°29'E) and Ziwani (10°20'S, 40°18'E) in Mtwara District, Mtwara Region, Tanzania (Honest, 1996).

Diagnosis: This galago is remarkable for its small size being, on average, both shorter (head-body length) and less heavy than *G. demidoff*, which was the smallest known galago (Nash *et al.*, 1989). The dorsal pelage of *G. rondoensis* is a mid-brown in contrast to that of *G. demidoff* which is rufous to reddish-brown (Nash *et al.*, 1989). The tail is noticeably different from *G. demidoff*, being bottle-brush shaped (last third being more bushy).

Species Characteristics:

Vocalisations: The vocal profile of *G. rondoensis* is distinct from that of any other galago species (Honest, 1996). The structure of the advertisement call (single unit rolling call) is illustrated by the oscillogram in Fig. 1. The results of an analysis of variance in two parameters of the advertisement call of *G. rondoensis* and two other species is shown in Table 3. All comparisons show a significant difference, except that of unit length between *G. granti* and *G. rondoensis*, which belies the considerable difference in the structure of their advertisement calls. When the number of subunits per unit of the advertisement call is examined it is found that *G. granti* shows a pattern of continual increase from start to finish, whereas *G. rondoensis* shows no pattern of change (Honest, 1996).

Penile Morphology: The penises of the similar-sized *G. rondoensis* and *G. demidoff* are considerably different in shape (Fig. 2), although the occurrence of spines may not be valuable in this comparison as the *G. rondoensis* examined was not fully mature.

It is clear from the calls and penile morphology that *G. rondoensis* is conspecific with neither *G. demidoff*, nor any other species (see Figs. 1 & 2). There is only one

other small galago in south-eastern Tanzania, *G. granti*. *G. rondoensis* and *G. granti* are sympatric at Rondo (Honest, 1996). The advertisement call of *G. rondoensis* is most similar to *G. udzungwensis*, but significant differences exist between them in calls, body size and other morphological differences (*e.g.*, penile morphology and tail shape) which justify their taxonomic separation.

Pelage: Dorsum: Uniform mid-brown, with grey underfur. Ventrums: Much paler than the dorsum being a pale yellow with grey underfur. Deeper yellow under the chin and on the underside of the neck. Face: As dorsum. Whitish nasal stripe present. No obvious eyerings. Tail: As dorsum but with a rufous wash.

Cranial Dimensions (Honest, 1996): see Table 2.

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References

- Bearder, S.K., P.E. Honest & L. Ambrose. 1995. Species diversity among galagos with special reference to mate recognition. In: *Creatures of the Dark: The Nocturnal Prosimians*, L. Alterman, M.K. Izaard & G.A. Doyle, eds. Plenum Press, New York, pp. 331–352.
- Courtenay, D.A.O. & S.K. Bearder. 1989. The taxonomic status of bushbabies in Malawi with emphasis on the significance of vocalisations. *International Journal of Primatology* 10: 17–34.
- Dixon A.F. 1987. Observations on the evolution of the genitalia and copulatory behaviour in male primates. *Journal of the Zoological Society of London* 213: 423–443.
- Dixon, A.F. 1989. Effects of sexual selection upon the genitalia and copulatory behaviour in male galagos.