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NATURAL HISTORY OF THE SOMALI LESSER GALAGO (*GALAGO GALLARUM*)

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ABSTRACT

The Somali lesser galago *Galago gallarum* is a little-known nocturnal, arboreal, primate of Ethiopia, Somalia and Kenya that lives in dryer habitats than any other primate in Africa. This paper presents an overview, based upon a detailed review of the literature and on our own preliminary observations, of what is known about the taxonomy, distribution, abundance, ecology, behaviour and conservation status of *G. gallarum*. We found *G. gallarum* to be relatively easy to identify and observe in the field, and to be sympatric with the northern lesser galago *Galago senegalensis* in Meru National Park. The phenotypic characters, habitats and loud (advertisement) call of *G. gallarum* are distinct, as are some of its behaviours.

INTRODUCTION

The Somali lesser galago (or Somali bushbaby) (*Galago gallarum* Thomas, 1901) is one of Africa's least known primates. This paper reviews what is known about the taxonomy, distribution, abundance, ecology, behaviour and conservation status of *G. gallarum* and presents new data based upon our preliminary observations of this species in Kenya during 2003-2004 (De Jong & Butynski, 2004).

METHODS AND STUDY SITES

Most of our data on galagos were collected during the several hours following dusk (*i.e.* after ca. 19:00 h) or during the few hours before dawn (*i.e.* prior to ca. 06:00 h). We searched for and located *G. gallarum* primarily to (1) determine presence at various sites, (2) obtain a rough indication of abundance in various habitats, and (3) gather preliminary information on ecology, behaviour and habitat requirements. Date were also collected during the day on

galagos that were located during the previous night and followed to their sleeping sights, and on the plant species composition and structure of the vegetation of each habitat. Headlamps and hand-held spotlights were used to locate and observe galagos. Galagos were viewed through Leitz and Zeiss binoculars, and recordings of vocalizations were made using a Marantz PMD222 tape recorder and a Sennheiser K6 microphone. Locations were determined using a Garmin, Etrex Venture Global Positioning System. Photographs were taken using a Canon Eos 100 camera with Canon zoom EF 75-300 mm lens.

Rough estimates of the 'minimum density' of *G. gallarum* for a particular site were obtained by (1) standing at a fixed point and noting the number of individuals giving loud calls from different locations within 100 m of the researcher over a period of 2 minutes, and by (2) searching for galagos while walking through the site and then making a conservative estimate of the number of individuals seen per hectare searched.

Surveys for galagos were conducted during eight nights in Meru National Park and Kora National Reserve, Kenya (11–19 September 2003), during one night at a site ca. 80 km south of Moyale, Kenya (8 October 2003), and during four nights in Shaba National Reserve, Kenya (27 February–2 March 2004). During these surveys, a total of 52 h were spent either searching for or watching galagos. In addition, surveys were undertaken during one night each at three sites in southern Ethiopia; Genalé River on 4 October 2003, Bidree on 6 October 2003, and Wachi on 7 October 2003) (table 1).

Table 1. Sites surveyed for galagos in central Kenya and southern Ethiopia during September 2003–March 2004.

Site name	Location (elevation)	Number surveys (total hours)	Galagos found (number)
Meru N.P., Kenya	0° 04' 52" S; 38° 22' 47" E (370–600 m)	By foot 8 (13 h) By vehicle 6 (17 h)	*G. gallarum* (24) *G. senegalensis* (2)
Kora N.R., Kenya	0° 09' 13" S; 38° 43' 01" E (400 m)	By vehicle 1 (6 h)	*G. senegalensis* (12)
Moyale, Kenya	03° 30' 37" N; 38° 40' 03" E (800 m)	By foot 2 (5 h)	*G. gallarum* (11)
Shaba N.R., Kenya	0° 41' 33" N; 37° 50' 55" E (800 m)	By foot 3 (4 h) By vehicle 3 (7 h)	*G. gallarum* (3)
Genalé R., Ethiopia	05° 59' 55" N; 39° 42' 15" E (1,130 m)	By foot 2 (2 h)	*G. senegalensis* (1)
Bidree, Ethiopia	05° 56' 31" N; 39° 39' 45" E (1,680 m)	By foot 2 (3 h)	*G. senegalensis* (3)
Wachi, Ethiopia	04° 13' 01" N; 38° 26' 41" E (1,500 m)	By foot 2 (2 h)	None

The surveys were conducted by the two authors, either on foot or from a slow-moving Land Rover. The 13 "foot surveys" conducted in Kenya ranged in time from 0.3–3.5 h ($\bar{x}$= 1.6 h, SD 1.0). The nine "vehicle surveys" conducted in Kenya ranged in time from 1.5–8.0 h ($\bar{x}$ = 3.0 h, SD 2.3) (table 1). Both during foot and vehicle surveys, we moved slowly while using one or two spotlights to visually search for the eye-shine of galagos. We also stopped frequently to listen for the loud calls of galagos. Upon encountering a galago, we did not attempt to collect data systematically, but detailed notes were made on location, habitat and behavioural-ecology.

During the surveys in Kenya, a total of 38 *G. gallarum* and 14 *G. senegalensis* were located (table 1). Site descriptions, times of surveys, numbers of galagos encountered per survey, other species of primates present, and other details are provided in De Jong and Butynski (2004). Copies of all tape recordings are with the Nocturnal Primate Research Group, Oxford Brookes University, Oxford, UK.

TAXONOMY

G. gallarum was named and first recognized as a species by Thomas (1901). Later this taxon was subsumed as one of many subspecies of the northern lesser (Senegal) galago (*Galago senegalensis* É.Geoffroy Saint-Hilaire, 1796). Based on an extensive study of galagos (4,949 specimens from 57 museums and private collections), and on inferred areas of sympatry based on the sites at which specimens of *G. gallarum* and *G. senegalensis* were collected, Olson (1979, 1986) elevated this taxon back to full species status, a classification that has not been disputed (Nash *et al.*, 1989; Bearder *et al.*, 1995; Kingdon, 1997; Masters & Bragg, 2000; Masters & Brothers, 2002; Grubb *et al.*, 2003). Groves' (2001) revision of primate taxonomy also recognizes *G. gallarum* as a distinct species, primarily based on ear, hindlimb, hindfoot and tail lengths relative to *G. senegalensis senegalensis*.

We found the field identification characters, loud call and preferred habitat of *G. gallarum* to be distinct from those of all other galagos (see below). In addition, we found *G. gallarum* to be sympatric with *G. senegalensis* in Meru National Park. These observations all lend considerable additional weight to the designation of *G. gallarum* as a 'good' species. At this time, *G. gallarum* is considered a monotypic species (Groves, 2001; Grubb *et al.*, 2003).

DESCRIPTION

G. gallarum is a medium-sized galago with a whitish face and throat, and contrasting dark brown eye-rings, and black ears and tail (figures 1, 2 & 3). Males and females look alike, but males are slightly larger than females. Body measurements for adult males are 3-6% longer for adult males than for adult females (table 2). No data are available on body weights for *G. gallarum*, but, as in other *Galago* spp, males are likely to be 10-20% heavier than females (Izard & Nash, 1988; Harcourt & Bearder, 1989). Muzzle is short, almost black over the distal half. Face, throat, chest and belly pelage is off-white, with a greyish tint on the ventrum. Interocular stripe is off-white and broad. Eye-rings are dark brown, narrow, and sometimes incomplete laterally. There is a black 'tear line' from the inner corner of the eyes down the sides of the muzzle. Eyes are large and orange-brown, and support a bright orange eye-shine at night in the light of a spotlight. Ears are black both front and back. Dorsal pelage is short (not woolly) and varies in colour from light sandy brown to buff to fulvous, being lighter on the head. Shoulders are buff or light rufous. Outer forelimbs and hands are buff to sandy-brown. Hips, outer hindlimbs and feet are yellowish-buff. Tail is mostly black but dark brown or reddish towards the base. The young are similar to adults in colour.

Standard body length measurements for *G. gallarum* are available from two sources (Olson & Nash, in press; J. Masters pers. comm.). These authors apparently referred to many of the same specimens, so the samples are not independent of one another (table 2).

Figure 1. Large juvenile Somali lesser galago Galago gallarum *in Meru National Park, Kenya. Note the contrasting black and white parts of the head, especially the shiny black ears. Photo by Yvonne de Jong.*

Figure 2. Somali lesser galago Galago gallarum *in Meru National Park, Kenya. Note the contrasting black and whitish parts of the head, especially the shiny black ears. No other species of galago has this head pattern. Photo by Yvonne de Jong.*

Table 2. Summary of body measurements for the Somali lesser galago Galago gallarum*.*

Males and females combined (Olson & Nash in press)
Head + body length: mean = 167 mm; range = 130-200 mm; n = 25
Tail length: mean = 252 mm; range = 205-293 mm; n = 25
Hindfoot length: mean = 62 mm; range = 57-75 mm; n = 25
Ear length: mean = 35 mm; range = 30-40 mm; n = 27

Adult males (J. Masters, pers. comm.)
Overall length: mean = 436 mm; range = 415-464; n = 8
Head + body length: mean = 178 mm; range = 154-196 mm; n = 8
Tail length: mean = 259 mm; range = 245-274 mm; n = 8
Hindfoot length: mean = 67 mm; range = 64-70 mm; n = 6
Ear length: mean = 35 mm; range = 28-38 mm; n = 7

Adult females (J. Masters, pers. comm.)
Overall length: mean = 413 mm; range = 380-443; n = 9
Head + body length: mean = 168 mm; range = 145-181 mm; n = 9
Tail length: mean = 246 mm; range = 227-271 mm; n = 9
Hindfoot length: mean = 63 mm; range = 60-71 mm; n = 9
Ear length: mean = 34 mm; range = 32-37 mm; n = 4
Skull length: mean = 42.5 mm; range = 40.2-45.5; n = 12 (Schwarz, 1931)
mean = 42.8; SD = 2.2; n = 5 (Masters & Bragg, 2000).

*There are no body weight data available for *G. gallarum*

At night, under the light of a spotlight, the dark brown or black muzzle, eye-rings, ears and tail contrast strongly against the whitish face and pale (sandy and buff) body. Under these conditions, this galago often appears greyer on the dorsum than when seen in daylight or when held in the hand. It seems that the bright light from the spotlight 'catches' the grey basal portion of the hairs of the dorsum more than the light sandy-brown or buff tips of these hairs.

DISTINGUISHING CHARACTERS

G. gallarum is sympatric with only two other galagos with which it might be confused. Based on museum studies, *G. senegalensis* is at least narrowly sympatric with *G. gallarum* on the north and southwest fringes of the range of *G. gallarum* (Olson, 1986; Nash *et al.*, 1989; T. Olson, pers. comm.), and probably also along much of the west and northeast fringe.

The 'woo 1' (or 'honk') loud call of *G. senegalensis* is distinctive. The 'woo 1' is a single-unit, low-pitched call that is repeated at regular intervals for up to 1 h (Zimmermann *et al.*, 1988; Nash *et al.*, 1989; Zimmermann, 1990; Butynski & De Jong, pers. obs). The pelage of *G. senegalensis* is long, thick and wooly, and the dorsum is grey or brownish-grey. Ears are brown or greyish on the back and pinkish or flesh-coloured on the front. There is a sharp delineation between the lemon yellow of the outer hindlimbs and the grey of the upper thigh and dorsum. Tail is grey to brown. *G. senegalensis* is generally in more moist habitats (*e.g.* woodland, forest) than *G. gallarum*. *G. senegalensis* has the following measurements (males and females combined) compared to *G. gallarum* (Olson & Nash, in press):

Ears longer: mean = 40 mm; range = 21-57; n = 483
Hindfoot longer: mean = 67 mm; range = 52-78; n = 498

Figure 3. Adult Somali lesser galago Galago gallarum*. Note the distinctive contrast between the dark and light coloured body parts, a pattern that distinguishes* G. gallarum *from other species of galagos with which it is sympatric. Drawing by Stephen Nash.*

Skull length of the two subspecies of *G. senegalensis* that are sympatric with *G. gallarum* (*i.e. braccatus, dunni*) is longer (mean=44.8 mm, n=13; Groves, 2001). For *G. s. braccatus* alone, skull length is also longer (mean=44.6 mm, range=42.1-46.9, n=19; Schwarz, 1931).

The best single measurement for distinguishing *G. senegalensis* from *G. gallarum* is ear length (Masters, 1998; Masters & Bragg, 2000). See key and measurements in Schwarz (1931).

One striking difference in the field between *G. gallarum* and *G. senegalensis* is that *G. gallarum* is a much more 'confident', less 'shy', species. Upon being located with the light of a spotlight, *G. gallarum* typically remains in place for a few minutes and then often moves towards the observer, frequently to within 5 m and sometimes to within 1 m. The impression is that this species almost immediately begins to take advantage of the light from the spotlight to locate invertebrates. In contrast, *G. senegalensis* usually immediately moves away from the observer.

The Kenya coast galago [*Galagoides cocos* (Heller, 1912)] is a recently resurrected species (Bearder *et al.*, 2003; Grubb *et al.*, 2003) that the literature of the past few decades refers to as the Zanzibar galago *Galagoides zanzibaricus* (*e.g.* Olson, 1979; Nash, 1983; Harcourt & Bearder, 1989; Nash *et al.*, 1989; Groves, 1993, 2001; Bearder *et al.*, 1995). *G. cocos* is probably also narrowly sympatric with *G. gallarum*, or nearly so, along the southeast fringe of the range of *G. gallarum* in Kenya and Somalia. . The loud 'incremental' advertisement call of *G. cocos* is distinctive (Zimmermann, 1990; Bearder *et al.*, 1995; Butynski & De Jong, 2004). The loud incremental call is described by Nash *et al.* (1989) as a, "sequence of up to 18 double or triple units usually lasting a total of 3-6 seconds, reaching a crescendo over the first few units and frequently trailing into a rapid series of staccato notes of lower frequency." The ears are brownish, dorsum and outer limbs brown to cinnamon, ventrum light cream to yellowish, and tail reddish-brown (Nash *et al.*, 1989; Butynski, pers. obs.). *G. cocos* lives in more moist habitats (*e.g.* coastal and riverine forest), and usually at lower elevations, than G. *gallarum* (Butynski & De Jong, pers. obs).

In the field, in the light of a spotlight, *G. senegalensis* and *G. cocos* do not have a dark brown or black muzzle, eye-rings, ears, or tail that contrast sharply against a whitish face and pale (sandy and buff) body as for *G. gallarum.* The best single field character for distinguishing *G. gallarum* is that its ears are black, while the ears of *G. senegalensis* and *G. cocos* are grey or brown, respectively, with some pink visible in the lower front of the ear.

DISTRIBUTION

G. gallarum is endemic to the semi-arid thorn scrub and thorn scrub/woodland of eastern Kenya, southern Ethiopia, and Somalia where, in most places, it is the only small galago present. The limits of the geographic distribution of this species are poorly understood (Drake-Brockman, 1910; Jenkins, 1987; Nash *et al.*, 1989; Yalden *et al.*, 1996; Perkin & Butynski, in press; De Jong & Butynski, 2004; P. Grubb, pers. Comm.; T. Olson, pers. comm. This is the result both of a small number of specimens and recorded sightings, and of confusion with *G. senegalensis*. *G. gallarum* is not known to occur west of the vicinity of the Tana River, Meru National Park, Shaba National Reserve or Lake Turkana in Kenya, or Abyssinian Plateau in Ethiopia. The northern limit is usually given as the southern base of the Abyssinian Plateau, Ethiopia. The known northeastern limit is Odweina near the Red Sea in northern Somalia, while the southeastern limit lies near the Shabeelle River in south-central Somalia. There, however, appears to be no good reason why *G. gallarum* should not occur farther east than this. The known southern limit is the coastal forest stripe along the Indian Ocean from the Shabeelle River, Somalia, south to the Tana River, Kenya (figure 4).

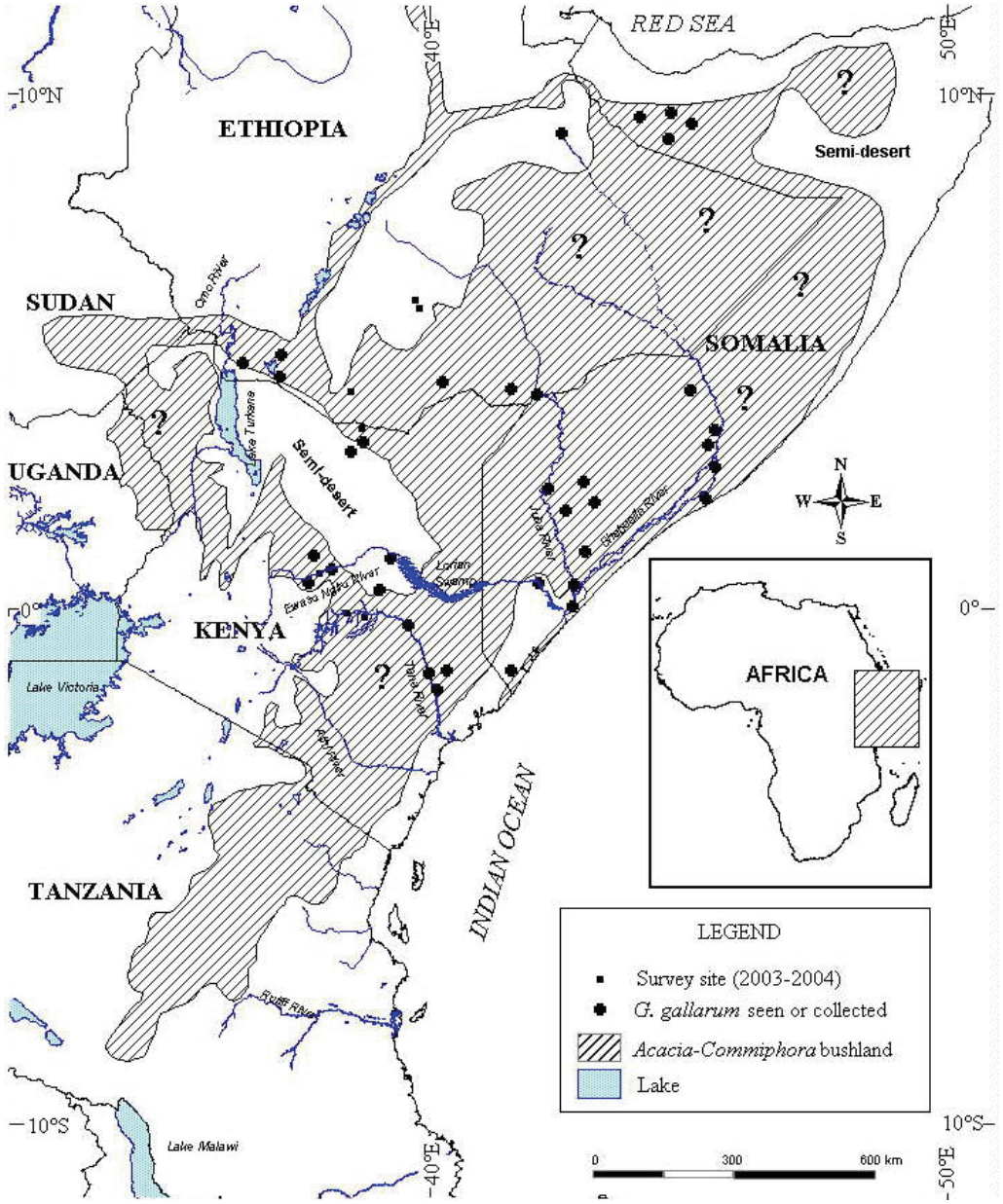

Figure 4. Localities for the Somali lesser galago Galago gallarum *based on sites at which museum specimens have been collected and on sites where the authors have observed this species. Also shown are the sites at which surveys were conducted during this study (see table 1). Locality points were taken from Lönnberg, 1913; De Beaux, 1922, 1924, 1934, 1937; Masters, 1998; Perkin & Butynski, in press; C. Groves, pers. comm.; M. Dodds, pers. comm.; P. Agnelli, pers. comm.; T. Olson, pers. comm.; Butynski & De Jong, pers. obs. The shaded area represents the 'Somalia-Masai* Acacia-Commiphora *deciduous bushland and thicket' vegetation type as defined and mapped by White (1983). Note that nearly all of the localities where* G. gallarum *is known to occur fall within this vegetation type or within the 'Somalia-Masai semi-desert grassland and shrubland' vegetation type (White, 1983).*

We found *G. gallarum* at several sites in the Meru National Park, including sites where *G. gallarum* is sympatric with *G. senegalensis*. Although the localities presented for museum specimens suggest that *G. gallarum* and *G. senegalensis* are sympatric in southern Ethiopia and along the Tana River, Kenya (Olson, 1986; Nash *et al.*, 1989; T.R. Olson in litt toYalden *et al.*, 1996), this is the first time that the two species have been documented living in close proximity at the same site. Although we spent one night (6 h) searching for *G. gallarum* in Kora National Reserve near Adamson's Bridge, we did not find *G. gallarum* there, even though *G. senegalensis* was common. It,therefore, remains uncertain whether *G. gallarum* occurs on the right (west) bank of the Tana River. We also found *G. gallarum* at one site in Shaba National Park, and at one site 80 km southwest of Moyale (table 1, figure 4).

Three widely spaced sites were briefly visited by TMB in southern Ethiopia in October 2003 (table 1). *G. senegalensis* was found at the Genalé River site (1,130 m) and the Bidree site (1,680 m), but not *G. gallarum*. The Genalé River site looked suitable for *G. gallarum* but the time there was too short to be certain that *G. gallarum* was not in the vicinity. The Bidree and Wachi (1,500 m) sites are probably too high for *G. gallarum*.

HABITAT

G. gallarum is nocturnal and arboreal, living in drier, 'thornier' habitats than any other galago, or indeed, any other African primate. *G. gallarum* appears to prefer *Acacia-Commiphora* deciduous bushland and thicket, and small trees (<15 m in height) (figure 5). This is not a true 'woodland' species as sometimes reported (*e.g.* Drake-Brockman, 1910; Groves, 2001), but does occur in 'bushed woodland' (figure 6). *G. gallarum* is absent from open woodland and open bushland were the mean distance between bushes or trees is greater than ca. 3 m, and where fewer than about four woody species are present. In Kenya, the habitat of *G. gallarum* is dominated by 2-15 m high, moderately to very closely spaced bushes and trees with dense thorns or spines, at least some of which produce gum. Ground vegetation (grass and herbs) varies from dense to absent. Soils are well drained, rocky or sandy, not loamy.

Altitudinal and rainfall limits of the species' range are poorly documented. We estimate the limits of annual rainfall within the range of *G. gallarum* to be 200–600 mm. The known altitudinal range is ca. 150–1100 m in Kenya (T. Butynski, pers. obs.), and to 1200 m (at Odweina) in northeastern Somalia (Drake-Brockman, 1910).

At pristine sites in Meru National Park (425–600 m), where *G. gallarum* is relatively abundant, the following woody species are common: hook-thorn *Acacia mellifera*, umbrella thorn *Acacia tortilis, Commiphora holtziana, Commiphora samharensis, Terminalia orbicularis, Terminalia spinosa,* boscia *Boscia coriacea*, *Dobera glabra,* doum palm *Hyphaene compressa* and *Euphorbia bussei*. The area is especially rich in *Commiphora* spp., but *A. tortilis* is the dominant and tallest tree (ca. 15 m) in many places.

At a site ca. 80 km south-west of Moyale (800m, Kenya/Ethiopia border) that is used intensively by people and their livestock and severely degraded, *G. gallarum* is particularly common in *A. mellifera*-dominant bushland and thicket where the following other woody species are present: Egyptian thorn *Acacia nilotica,* false umbrella thorn *Acacia reficiens, B. coriacea* and sickle bush *Dichrostachys cinerea*. The tallest trees are about 7 m.

Figure 5. Typical bushland habitat in Shaba National Reserve, Kenya, in which the Somali lesser galago Galago gallarum *is present at low densities. The dominant trees here are* Acacia *spp. and* Commiphora *spp. The woody vegetation here is leafless for much of the year. Photo by Yvonne de Jong.*

Figure 6. Typical bushed woodland habitat in Meru National Park, Kenya, in which the Somali lesser galago Galago gallarum *is common. The dominant trees here are* Acacia mellifera *and* Acacia tortilis*. The woody vegetation here is leafless for much of the year. Photo by Yvonne de Jong.*

Near Turbi, Kenya, one *G. gallarum* was found during the day in an acacia about half way up a large inselberg (M. Dodds, pers. comm.). Here, at ca. 1,100 m, the rock was mostly bare with clumps of small *Acacia* spp. and *Commiphora* spp.

ABUNDANCE

G. gallarum is absent from large areas of unsuitable habitat within its geographic range. Over much of the range the density is probably less than one animal/ha but densities are much higher than this at some sites. For example, in Meru National Park some sites hold >4 animals/ha, while the Moyale site in northern Kenya supported an estimated >5 animals/ha.

LOCOMOTION AND ANTI-PREDATOR BEHAVIOUR

G. gallarum can move with surprising speed through the thorniest of vegetation (*e.g. Acacia* spp, *D. cinerea, T. spinosa*). When on bushes and trees, this galago moves quadrupedally, headfirst much as a tree squirrel, even when moving vertically downwards. Adults are capable of horizontal leaps of >2.5 m between branches. Because bushes and trees are often more than a few metres apart, adults frequently come to the ground to hop bipedally to the next bush or tree; adults seen to jump from >1.3 m to the ground, make a series of 2 m long hops, and then leap >1 m up into a bush or tree. When moving on the ground where the distance between trees is greater than can be covered by three hops, *G. gallarum* may stop (sometimes on a small rock) after a few hops to scan (while standing on its hind legs) for several seconds before moving on.

The vision, sense of smell and hearing of *G. gallarum* appear to be well developed. The ears are highly mobile and are often moved independently of each other. The ears and hindfeet of *G. gallarum* are shorter than those of the similar-sized *G. senegalensis*. These may be adaptations for moving through very thorny vegetation.

G. gallarum probably receives a high level of protection from predators by the camouflage afforded by its pelage, its keen eyesight, hearing, and quickness, and by the extremely dense, thorny/spiny, vegetation in which it lives. It seems likely that none of the many potential predators would have much success capturing this highly mobile galago while it is among the dense thorns common to most trees in its habitat. *G. gallarum* is particularly cautious prior to coming to the ground, suggesting that that is when it is most vulnerable to predators.

There are no data on the predators, parasites or diseases of *G. gallarum*. The many potential predators include large snakes, common jackal *Canis aureus*, black-backed jackal *Canis mesomelas*, mongooses *Herpestes* spp., genets *Genetta* spp., wild cat *Felis sylvestris*, serval *Felis serval*, caracal *Felis caracal*, and numerous diurnal and nocturnal raptors.

FORAGING AND DIET

When active, *G. gallarum* spends most of the time foraging in bushes and trees. Foraging occurs at all heights from ground level to near the top of the tallest trees (ca. 15 m), but mostly at 1–7 m. The mean height above the ground of 14 *G. gallarum* at the moment they were detected was ca. 5.2 m (range = 1-10 m; SD = 2.8).

Foraging for invertebrates on the ground usually occurs under the cover of dense bushes or herbs. *G. gallarum* was seen to pounce on large (>4 cm long) invertebrates on the ground from a height of >1 m.

The diet of *G. gallarum* remains little known. Kingdon (1997) states that the diet is, "presumed to be mainly gum and invertebrates". Gum is indeed frequently eaten, and our preliminary observations during the driest months indicate that most of the time foraging is spent intensively searching for invertebrates. No feeding on fruit has been observed, but it is likely that at least some fruit is eaten when available. Most of the trees in the range of *G. gallarum* have wind-dispersed, winged seeds that *G. gallarum* are unlikely to eat. Fleshy, animal-dispersed fruits are probably uncommon (and seasonally absent) over much or all of the range of *G. gallarum*. This might be the galago with the highest portion of animal matter in the diet. This species does not require 'free-water'.

An adult female and large juvenile in Meru National Park were observed for several evenings and mornings. Both fed repeatedly on gum of a *Commiphora* sp. at heights from 0.5–9 m and searched very actively for invertebrates for long periods in the *Commiphora* sp. and *A. tortilis*. Much of the gum they ate was from sites damaged by foraging bush elephants *Loxodonta africana*.

One *G. gallarum* found 2 m up in a 3 m tall *Wrightia demartiniana* tree at 11:00 h near Turbi Village was harassed for at least 30 minutes by about five eastern violet-backed sunbirds *Anthreptes orientalis* (M. Dodds, pers. comm.). This animal was probably sleeping when discovered by the sunbirds. As a highly active omnivore with a body weight of about 200 g, it is likely that *G. gallarum* eats the eggs and nestlings of small birds, as well as the neonates of small arboreal mammals.

SLEEPING SITES

No use of tree holes for sleeping has been observed, but most habitats have few or no trees large enough to provide holes big enough for *G. gallarum* to enter. This galago probably most often sleeps (outside of a nest) on branches surrounded by a dense barrier of thorns or spines. No nest building has been reported but the nests of other species are sometimes used. For example, one adult, at 06:05 h, entered the hole of a 'grass ball' bird or rodent nest ca. 5 m up in an *A. mellifera* that held about six such nests. These nests were all located within dense clumps of thorns. If nest building occurs it is probably seasonal as most bushes and trees within the range of *G. gallarum* are without leaves (for nest building) much of the year.

In one case, an adult female and large juvenile settled on a 3 cm diameter branch at 11 m in the fork of a 13 m tall *A. tortilis* at 06:35 h. When this pair was revisited at 10:10 h, they had moved to an adjoining 13 m tall *Commiphora* sp. were they sat on a 10 cm diameter forked branch at 11 m. At both sites, they rested among dense branches and thorns. Both trees lacked leaves yet the two animals were difficult to detect. In another case, an adult female and large juvenile moved fast from 0.5 to 5 m above the ground at 5:45 h to (apparently) sleep near the top of a 5 m tall *E. bussei*.

SOCIAL AND REPRODUCTIVE BEHAVIOUR

As with other *Galago* spp. (Bearder *et al.*, 2003), *G. gallarum* live either alone or in small groups. *G. gallarum* is usually seen alone, but it is not uncommon to find two animals within

5 m of each other. The largest number seen together (*i.e.* within 5 m) was three. Of 38 encounters with *G. gallarum* in Meru National Park and Kora National Reserve, single individuals were encountered 31 times (82%) and pairs were encountered seven times (18%). Adults scent mark by rubbing the chin and hands against branches.

During our study, we identified and tape-recorded, for the first time, the species-specific loud 'quack' (advertisement) call for *G. gallarum*. While we expected the loud call of *G gallarum* to be different from the loud call of *G. senegalensis*, we were surprised as to just how extremely different the loud calls of these two species are. The rapid four unit, explosive, 'quack' is repeated many times and grades into rapid three, two and one unit calls. There are often more than 30 'quack' calls in a series. The 'quack' call, therefore, has a strikingly different temporal pattern from the single-unit 'woo 1' call of *G. senegalensis*. There is little or no overlap between these two loud calls in terms of unit duration or inter-call interval. In fact, to the human ear, the two calls hold no resemblance to one another. Upon hearing the 'quack' call, one expert on the loud calls of galagos, stated that this loud call is "completely unknown to me---not heard before!" (S. Bearder, pers. comm.). The 'quack' is probably used in the context of long-distance spacing and territoriality. Once sonograms are available from our recordings of the 'quack' calls, we will undertake a detailed, quantitative, comparative study of the loud calls of *G. gallarum, G. senegalensis, G. moholi, and G. cocos*.

Where *G. gallarum* densities are relatively high (> 4 animals/ha) there may be a 'dawn chorus' of 'quack' calls for ca. 10 minutes (from ca. 05:40–05:50 h when first light is at ca. 06:00 h). The human ear can hear the 'quack' at >300 m. A 'dusk chorus' has not been heard, but some 'quacks' are given within 1 h after dusk (19:00 h) and may be common during the first 5 h after dusk. Not surprisingly, the incidence of 'quack' calls appears to be directly related to population density. Other calls heard and recorded are described as 'yaps', 'chitters' 'pings' 'buzzes', and 'woos' (but these 'woos' differ in tone from those of *G. senegalensis* and the interval between 'woos' is shorter).

In Meru National Park, an adult female and large juvenile groomed themselves and each other on body and face at 06:23 h for ca.13 minutes at 6 m above the ground. The large juvenile then clung to the fur on the ventrum of the female and was carried rapidly upwards 5 m to a resting place located at 11 m. The large juvenile remained in a clump of two relatively large and four small trees (fig. 6) for at least 3 days, but probably for more than 8 days (since it was still in the clump of trees when we returned to the site on day 8). During this time, the adult female foraged up to at least 50 m away while the large juvenile foraged among the six trees.

Carrying young on the fur has not previously been reported for any *Galago* spp, and is only known for four other species of galagos: thick-tailed greater galago *Otolemur crassicaudatus*, small-eared greater galago *Otolemur garnettii,* southern needle-clawed galago *Euoticus elegantulus*, and northern needle-clawed galago *Euoticus pallidus* (Bearder, 1999; Bearder *et al.*, 2003).

REPRODUCTION AND POPULATION STRUCTURE

There is almost no information on reproduction or population structure for *G. gallarum*. The rate of reproduction is unknown, but it is likely that two pregnancies per year is the norm, as for *G. senegalensis* and the southern lesser galago *Galago moholi*. Since *G. senegalensis* and *G. gallarum* have similar body weights, it is likely that these two species are similar in terms

of gestation length, litter size, birth weight, age at weaning, age at sexual maturity, and oestrus length (139–146 days, one, 15–23 g, 10–14 weeks, 15 months, 1–3 days, respectively, in *G. senegalensis*) (Izard & Nash, 1988; Zimmermann, 1989). This is an area where more research is needed.

Given the considerable seasonality of the region over which *G. gallarum* lives, reproductive activities are expected to be highly seasonal, with lactation and weaning coinciding with periods of maximum food availability (Nash, 1983; Butynski, 1988). In the region occupied by *G. gallarum*, the periods of maximum food availability are likely to be during the April–June and November-December wet seasons. If so, births might peak during the dry months of February-March and September-October. Twice in September 2003, we observed adult females with single large juveniles that were probably weaned. This suggests both that a single infant is (usually) born and that at least some births occur around March. A field study of *G. cocos* at Gedi (ca. 100 km south of the known southern limit of *G. gallarum*) found that this species has two pregnancies within 1 year, and that births occur during August-October and February-March, inclusive. This timing helps to ensure that there is maximum food available during lactation and weaning (Nash, 1983). This is the seasonal reproductive pattern that we also expect to see for *G. gallarum*.

CONSERVATION

G. gallarum is a fairly widespread species that is common at some sites. The expansive semi-arid area over which it lives is of little value for crop production. In addition, *G. gallarum* persists at sites were habitat degradation is severe due to overgrazing by domestic livestock. In Kenya, this galago occurs in several protected areas, including Meru National Park, Shaba National Reserve and Arawale National Reserve. Although *G. gallarum* has probably been extirpated from some sites, and it numbers may be in overall decline, its survival over the long term appears secure, primarily due to the relatively inhospitable habitats it prefers and it ability to withstand habitat degradation.

FUTURE RESEARCH

The research priorities for *G. gallarum* are:

1. Conduct extensive surveys to determine the geographic distribution of *G. gallarum*, as well as areas of sympatry with other *Galago* spp.
2. Undertake detailed field and museum studies to assess whether *G. gallarum* is a monotypic or polytypic species, as well as its evolutionary affinities with other *Galago* spp.
3. Conduct detailed, comparative, studies of the ecology and behaviour of *G. gallarum* in a wide range of habitats to assess intraspecific ecological and behavioural variation/flexibility, and compare these findings with those for other *Galago* spp.

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REFERENCES

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

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

Butynski, T.M. (1988). Guenon birth seasons and correlates with rainfall and food. In: A. Gautier-Hion, F. Bourlière, J.-P. Gautier & J. Kingdon (eds.), *A Primate Radiation: Evolutionary Biology of the African Guenons.* Cambridge University Press, Cambridge. Pp. 284-322.

Butynski, T.M. & Y.A. de Jong (2004). Confirmation of '*Galagoides cocos'* (Heller, 1912) as the name for the 'Kenya coast galago'. Unpublished report to Primate Action Fund and Primate Conservation, Inc., Washington, D.C.

De Beaux O. (1922). Mammiferi Abissini e Somali. *Atti della Società Italiana di Scienze Naturali e del Museo Civico, Milano* **61**: 21-34.

De Beaux O. (1924). Mammiferi della Somalia Italiana. Elenco delle specie e sottospecie finora riconosciute presenti con annotazioni di sistematica e zoo-geografia. *Atti della Società Ligustica di Scienze e Lettere (Genoa)* **3**: 149-168.

De Beaux O. (1934). Mammiferi raccolti dal Prof. G. Scortecci nella Somalia Italiana centrale e settentrionale nel 1931. *Atti della Società Italiana di Scienze Naturali e del Museo Civico, Milano* **73**: 261-300.

De Beaux O. (1937). Spedizione zoologica del Marchese Saverio Patrizi nel Basso Giuba e nell'Oltregiuba. Mammiferi. *Annali del Museo Civico di Storia Naturale, Genova* **58**: 50-173.

De Jong, Y.A. & T.M. Butynski (2004). Surveys of the Somali lesser bushbaby (*Galago gallarum*) and northern lesser bushbaby (*Galago senegalensis*) in Kenya and Ethiopia. Unpublished report to Primate Action Fund and Primate Conservation Inc., Washington, D.C.

DelPero, M., J.C. Masters, D. Zuccon, P. Cervella, S. Crovella & G. Ardito (2000). Mitochondrial sequences as indicators of generic classification in bush babies. *International Journal of Primatology* **21**: 889-904.

Drake-Brockman, R.E. (1910). *The Mammals of Somaliland.* Hurst and Blackett, London.

Groves, C. (1993). Order Primates. In: D.E. Wilson & D.M. Reeder (eds.), *Mammalian Species of the World: A Taxonomic and Geographic Reference* (2nd edition). Smithsonian Institution Press, Washington, D.C. Pp. 243-277.

Groves, C. (2001). *Primate Taxonomy*. Smithsonian Institution Press, Washington, D.C.

Grubb, P., T.M. Butynski, J.F. Oates, S.K. Bearder, T.R. Disotell, C.P. Groves & T.T. Struhsaker (2003). Assessment of the diversity of African primates. *International Journal Primatology* **24**: 1301-1357.

Harcourt, C.S. & S.K. Bearder (1989). A comparison of *Galago moholi* in South Africa with *Galago zanzibaricus* in Kenya. *International Journal of Primatology* **10:** 35-45.

Izard, M.K. & L.T. Nash (1988) Contrasting reproductive parameters in *Galago senegalensis braccatus* and *G. s. moholi. International Journal of Primatology* **9:** 519-527.

Jenkins, P.D. (1987). *Catalogue of Primates in the British Museum (Natural History) and elsewhere in the British Isles. Part IV: Suborder Strepsirrhini.* British Museum (Natural History), London.

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

Lönnberg, E. (1913). Mammals collected by the Swedish Zoological Expedition to East Africa. *Kungl Svenska Vetensk Akademiens Handlingar* **48**: 1-188.

Masters, J.C. (1998). Speciation in the lesser galagos. *Folia Primatologica* **69** (supplement 1): 357-370.

Masters, J.C. & D.J. Brothers (2002). Lack of congruence between morphological and molecular data in reconstructing the phylogeny of the Galagonidae. *American Journal of Physical Anthropology* **11**: 79-93.

Masters, J.C. & N.P. Bragg (2000). Morphological correlates of speciation in bush babies. *International Journal of Primatology* **21**: 793-813.

Nash, L.T. (1983). Reproductive patterns in galagos (*Galago zanzibaricus* and *Galago garnettii*) in relation to climatic variability. *American Journal of Primatology* **5**: 181-196.

Nash, L.T., S.K. Bearder & T.R. Olson (1989). Synopsis of galago species characteristics. *International Journal of Primatology* **10**: 57-80.

Olson, T.R. (1979). Studies on aspects of the morphology and systematics of the genus *Otolemur*. Ph.D. thesis, University of London, London.

Olson, T.R. (1986). Species diversity and zoogeography in the Galagidae. *Primate Report* **14**: 213.

Olson, T.R., & L.T. Nash (in press). Galago (Galagonidae) body measurements and museum collections data. *African Primates* **6.**

Perkin, A.W. & T.M. Butynski (in press). A note on the Somali galago *Galago gallarum*. *African Primates* **6**.

Schwarz, E. (1931). On the African long-tailed lemurs or galagos. *Annals and Magazine of Natural History* **7**: 41-66.

Thomas, O. (1901). Some new African bats (including one from the Azores) and a new galago. *Annals and Magazine of Natural History* series 7, **8:** 27.

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

Yalden, D.W., M.J. Largen, D. Kock & J.C. Hillman (1996). Catalogue of the mammals of Ethiopia and Eritrea. *Tropical Zoology* **9:** 73-164.

Zimmermann, E. (1989). Aspects of reproduction and behavioral and vocal development in Senegal bushbabies. *International Journal of Primatology* **10**: 1–16.

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

Zimmermann, E., S.K. Bearder, G.A. Doyle & A.B. Andersson (1988). Variations in vocal patterns of Senegal and South African lesser bushbabies and their implications for taxonomic relationships. *Folia Primatologica* **51**: 87-105.