

A survey of small carnivores in the Putu Mountains, southeast Liberia

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Abstract

A recent survey of small carnivores in a commercial mining exploration concession at the Putu Mountains, southeast Liberia, involved a broad area reconnaissance and camera-trapping. Camera-trap images of the recently described Bourlon's Genet *Genetta burloni* are the first published images of living individuals in the wild. This species is perhaps well distributed in the study area. Other small carnivore species found, including Honey Badger *Mellivora capensis*, are described. Liberian Mongoose *Liberiictis kuhni* was not detected, but local reports suggest that it was historically present and may persist at low density.

Keywords: *Genetta burloni*, Liberian Mongoose, *Liberiictis kuhni*, mining, Ratel

Un inventaire des petits carnivores des montagnes de Putu, au sud-est du Libéria

Résumé

Un inventaire des petits carnivores conduit récemment dans une concession d'exploration minière commerciale dans les montagnes de Putu, au sud-est du Libéria, impliquait une reconnaissance générale de la région avec une étude basée sur le piégeage photographique. Des clichés de la Genette de Bourlon *Genetta burloni*, décrite récemment, sont les premières images publiées d'individus vivants, en milieu sauvage. Cette espèce pourrait être bien distribuée dans la zone d'étude. D'autres espèces de petits carnivores qui ont été recensées, y compris le Ratel *Mellivora capensis*, sont décrites. La Mangouste du Libéria *Liberiictis kuhni* n'a pas été détectée, mais des mentions locales suggèrent qu'elle était présente par le passé et pourrait encore subsister à faible densité.

Mots clés: exploitation minière, *Genetta burloni*, *Liberiictis kuhni*, Mangouste du Libéria, Ratel

Introduction

Globally, the species richness of small carnivores, as with mammals as a group, is greatest in tropical areas, with about one-third of all species occurring in the Afrotropical realm (Schipper *et al.* 2008). The ecological role of tropical small carnivores remains poorly studied (Mudappa *et al.* 2007) but it is thought that they are important as competitors, predators and prey. In addition, they may be important seed dispersers with a vital role in forest regeneration (e.g. Mathai *et al.* 2010). Their natural history is mostly poorly understood and the distribution ranges of many species remain speculative (e.g. Djagoun & Gaubert 2009).

Liberia is situated in the Upper Guinea forest region, a part of the Guinean Forest Biodiversity Hotspot, where "exceptional concentrations of endemic species are undergoing an exceptional degree of habitat loss" (Myers *et al.* 2000). The only country that lies entirely within this region, it accounts for almost half the estimated area of remaining Upper Guinea Forest. Sapou National Park (Sapo NP), Liberia's only national park, covering 180,363 hectares, is a significant portion of the remaining southeast lowland rainforest block in the country and is at the centre of a large forest mosaic that has potential to provide a secure habitat for many threatened species. It is the closest-to-intact forest ecosystem in Liberia and remains tenuously connected by forest corridors to several other forest blocks in the southeast, such as the Grebo National Forest and the Krahn-Bassa National Forest.

The Liberian forest block is recognised as a global centre for viverrid endemism (Hoppe-Dominik 1990) and the Upper Guinea forests are a global priority area for small carnivore conservation (Schreiber *et al.* 1989). Despite this, the status of small carnivores in these areas is poorly known. This region

supports Liberian Mongoose *Liberiictis kuhni*, listed as Vulnerable on *The IUCN Red List of Threatened Species* (IUCN 2012). This global priority species for conservation (Schreiber *et al.* 1989) has a known distribution encompassing just a few forested locations in Liberia, including Sapou NP (Vogt *et al.* 2012), and Tai National Park in Côte d'Ivoire (Colyn *et al.* 1998). Discovered in 1958 (Schlitter 1974, Goldman & Taylor 1990) and considered a rainforest specialist, its range may already be shrinking with forest fragmentation and anthropogenic pressure (e.g. Taylor 1989), such as logging and the conversion of forest to farms. Liberia also contains the core habitat of the newly described Bourlon's Genet *Genetta burloni* (Gaubert 2003) which is listed as Near Threatened on the *IUCN Red List* (IUCN 2012) and is restricted to the Upper Guinea forests.

As Liberia emerges from conflict and rebuilds its forestry and agricultural sectors, the fate of forested landscapes such as those in the greater Sapou area is a great cause for concern. To exploit its rich natural resources, this area has been divided up into new commercial concessions for mining, and the production of timber, oil palm and rubber. While the government of Liberia has committed ten percent of timber profits to conservation and the establishment of a protected area network through the reform of its forestry sector, fundamental concerns have arisen directly relating to the revenue generated for conservation (SDI 2010, Global Witness 2012). Since 2010, for example, there has been a sharp rise in the issuance of Private Use Permits, which allow lower tax contributions to the government than do commercial contracts (Forest Management Contracts and Timber Sale Contracts). The establishment of commercial concessions that may overlap Sapou NP or its buffer zone, such as that of the Golden Veroleum oil palm company (Fricke 2010), further questions whether the political will is

present in Liberia to take on the challenge and responsibility of protecting these unique and biologically diverse forests. With just one national park currently gazetted and considering the uncertainty regarding the future development of a protected area network, it is critical to study the status of mammals in commercial concessions in order to understand conservation priorities within them and devise plans to minimise impacts on mammalian diversity.

This particular survey, commissioned by Putu Iron Ore Mining (PIOM), was conducted in 2010–2011. It was part of a larger study documenting the presence of all large mammal species across the concession area to gain information on their relative abundance and distribution, to assess the significance of the site to these animals and to assess the likely impact of iron-ore exploration and planned open-pit mining on their populations. The present report documents the small carnivore fauna of the Putu Range, southeast Liberia.

Study Site

Located north of Sapo NP, the Putu Range in Grand Gedeh County constitutes the only significant mountainous area in southeast Liberia. It is thought to harbour unique habitats and microhabitats not found in surrounding lowland areas. It is composed of two mountain ridges (Mt Ghi in the west and Mt Jideh in the east) running north-north-east to south-south-west, that reach a maximum elevation of just under 800 m a.s.l. on Mt Jideh. Because of its importance to the integrity of Sapo NP, the Putu Range was originally proposed as part of an extension area to the park. However, reflecting long-term commercial mining interest in the site, it was eventually excluded when the park was extended in 2003. In 2005, an exploration licence covering the Putu Range in a concession area of 425 km² (within 5°33'49"–47'22"N, 8°05'48"–16'40"W) was awarded to PIOM. Exploration intensified from December 2008 and continues at the present time.

The vegetation on Mt Jideh, where open-pit mining is planned, is probably the most botanically rich inside the concession. Although it is thought that clear-felling was conducted along its ridgeline about a century ago, it is largely composed of mature forest and the climate along the ridgeline and the summit has submontane affinities. The ridgeline of Mt Ghi, which was logged in recent decades, is composed of secondary forest, with a thick understorey in parts. Large gaps occur where some of the relatively few remaining large trees have fallen during windstorms. Most of the slopes are, however, composed of intact mature forest.

Lowlands in the PIOM concession comprise a mosaic of different habitats and transitional habitat types, in part consequential to commercial logging and the 14-year civil conflict (1989–2003) that saw fluctuations in the migratory and distribution patterns of the local human population. Recolonising secondary forest, disturbed swamp forest and large cleared areas of fallow farmland and/or Marantaceae fields with little canopy cover, occur. Lowland forest between the mountain ridges and west of Mt Ghi has regenerated and although patches of mature forest and large trees are rare, there is minimal disturbance. In contrast, the forest east of Mt Jideh, where the human population is largely concentrated along the motor-road, is highly disturbed and degraded.

Anthropogenic pressure in the form of hunting and artisanal gold mining by local people is of concern in the concession. In recent times both have intensified and represent a significant threat to mammal diversity in the area, with some gold mining camps supporting several hundred people. Gun-hunters tend to target large-bodied mammals, such as primates and ungulates, for commercial trade within Liberia, because of the higher income these animals generate (Green-grass 2011). Small carnivores, such as mongooses and African Civets *Civettictis civetta*, are caught in snares, which are often set in areas of cultivation. While the meat of these species is not usually sold, their commercial importance may rise in the future, given that present levels of harvesting of large-bodied mammals are potentially unsustainable.

Up to five different species of mongooses (Herpestidae), the Honey Badger (Ratel) *Mellivora capensis* (Mustelidae) and three or more species of civets and genetids (Viverridae) are thought to inhabit the Putu Range. Two species of otter (Mustelidae: Lutrinae), the African Clawless Otter *Aonyx capensis* and the Spotted-necked Otter *Lutra maculicollis*, are also thought to occur, but are not considered here: the survey focused on land habitats, with the main waterways insufficiently sampled.

Methods

Camera-traps were used because they are widely employed to survey elusive and nocturnal species, as well as those occurring at extremely low density (e.g. Carbone *et al.* 2001, Henschel 2008). A detection versus non-detection camera-trapping study was conducted between November 2010 and May 2011. Seven Cuddeback Capture 3.0 megapixel camera-traps and seven Camtrakker MK-12 camera-traps were initially deployed for a pilot study in November and December 2010. Later, 10 more Cuddeback camera-traps were added. Initially, some camera-traps were set with a lure, but the lure seemed to attract only African Civet so its use was discontinued. Cameras were set opportunistically near large fruiting trees, well-defined animal paths and stream banks, typically about 30 cm above the ground. They were set to operate throughout the 24-hr cycle. Cameras were set opportunistically near large fruiting trees, well-defined animal paths and stream banks. Up to six cameras were set on the same day along or in the vicinity of a particular reconnaissance search area and then retrieved after a period of time that varied from 10 to 30 days. The distance between cameras so grouped varied widely from a few meters to several kilometers. Camera-trap survey effort totalled 1,591 trap-days/nights. Camera-traps were placed in 18 clusters in four of the five main geographical areas inside the concession (Fig. 1). These were: i) the Eastern Lowlands that lie to the east of Mt Jideh and continue eastwards across the main motor-road where most villages are concentrated; ii) Mt Jideh, the largest and most easterly lying mountain which includes Mt Montroh that is an east–west trending extension of the northern end of Jideh; iii) the Central Valley, a large, extensive valley that lies between Mt Jideh and Mt Ghi; and iv) Mt Ghi, the most westerly lying mountain ridge that rises to an elevation of about 600 m a.s.l. Reflecting time constraints, the Western Lowlands, which are significantly more rugged than the Eastern Lowlands and less accessible to the local human

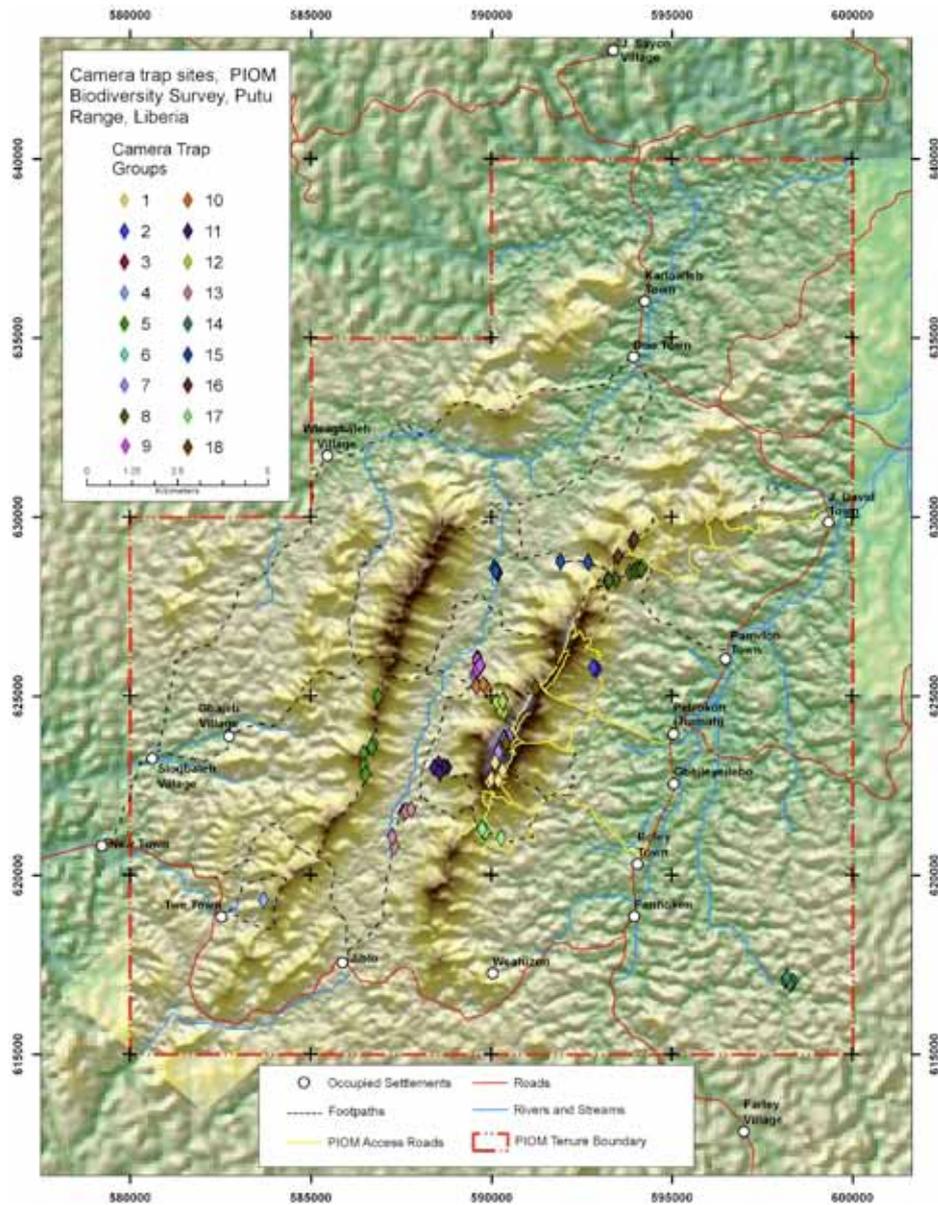


Fig. 1. Camera-trap locations inside the Putu Iron Ore Mining concession, Liberia. Grid: Universal Transverse Mercator zone 29.

population, were not surveyed with camera-traps. By the end of the survey, most camera-trap survey effort focused on Mt Jideh and the Central Valley; the former because it represented the site most likely to have been negatively affected by exploration activities and potentially most likely to be threatened by mining (see Table 1), the latter because it was close to the proposed mine area and was initially considered as a possible location for a mine waste dump.

A broad area reconnaissance using, in the most part, existing paths and tracks, was implemented to record encounter rates of mammals (e.g. number of animal signs per unit distance). Two people conducted those surveys: the author (EJG) and an ex-hunter guide (J. Cheflar) who had specialised knowledge of animal signs. Most reconnaissance searches (in short: ‘recces’) started between 06h30 and 07h00, to maximise direct encounters with diurnal mammals. Recces involved walking quietly through the forest at 1–2 km/h, on the predetermined survey routes and recording all encounters (direct

Table 1. Survey coverage of the Putu Iron Ore Mining concession, Liberia.

Geographical area	Total number of recces	Total distance covered (km)	Camera-trap effort (trap-days)
Eastern Lowlands	3	10.28	75
Mt Jideh	9	22.64	662
Central Valley	3	22.54	662
Mt Ghi	5	25.88	192
Western Lowlands	3	18.69	0

sightings, faeces, prints, vocalisations, etc.) of large and medium-sized mammals. All recces survey data were collected using a durable hand-held computer, a Personal Digital Assistant (Trimble Nomad 800 L) with Cybertracker software specially tailored to the type of data collected in the field. The Trimble Nomad had an inbuilt GPS and tracklog capability and Cybertracker software can use these data to determine dis-

tances walked and calculate encounter rates. However, these calculations proved inaccurate and because the distances were previously calculated using a Garmin GPSMAP 60CSx, encounter rates were calculated by hand. Data collected in the field were regularly downloaded into Cybertracker on a laptop computer.

The survey design, established during a preliminary investigation of the site in October and November 2010, comprised 23 recces (each of 1.22–10.61 km in length) covering a total distance of 100 km (see Fig. 2; recce 23 & 24 were subsequently walked as one recce). Approximately half of the total survey distance covered the two prominent mountain ridges. Each recce covered just one of the five geographical areas inside the concession but all geographical areas were covered (see Table 1). All but one of the recces were walked three times between December 2010 and April 2011. One recce was walked twice in December 2010 and January 2011.

Results

Mongoose (Herpestidae)

The survey confirmed the presence of three species of mongooses, all listed as Least Concern (IUCN 2012): Common Slender Mongoose *Herpestes sanguineus*, Marsh Mongoose *Atilax paludinosus* and Common Cusimanse *Crossarchus obscurus*.

Slender Mongoose was recorded in disturbed areas: it was occasionally and opportunistically sighted running across the main motor-road in the Eastern lowlands and across the PIOM roads on Mt Jideh during daylight hours. It was recorded once on a camera-trap in a fallow farm in the Eastern Lowlands, east of the village of Pennekon (see Fig. 1). It was never observed during the recce survey, which was mostly in closed-canopy forest.

Marsh Mongoose was camera-trapped 14 times, in six different locations, suggesting a wider distribution and larger numbers than other species of mongooses. Images – including those of

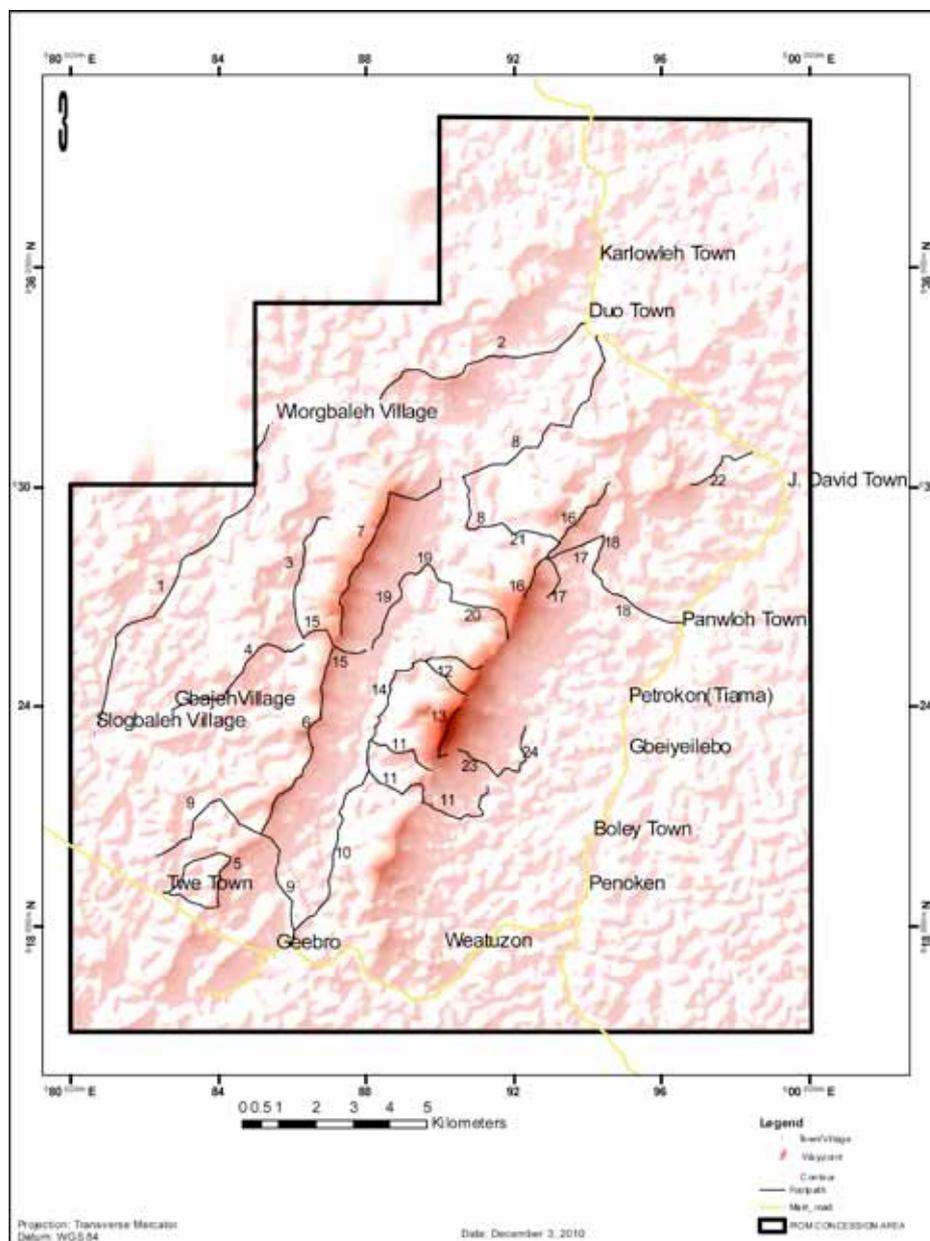


Fig. 2. Reconnaissance survey design inside the Putu Iron Ore Mining concession, Liberia. Grid: Universal Transverse Mercator zone 29.

young – were captured in a variety of habitat types: in closed-canopy forest on the mountain ridges, in farm bush and along PIOM roads on Mt Jideh, in areas that were being actively explored.

Common Cusimanse was the only small carnivore sighted during the recce survey. In December 2010, groups of Cusimanses were observed three times in closed-canopy forest on Mt Jideh and Mt Ghi; two encounters (on recce 7 and recce 17; Fig. 2) were of two individuals. This species was not encountered again until May 2011, when a group of about 10 was observed on the lower western slope of Mt Jideh. Cusimanse was once camera-trapped: on Mt Jideh during December 2010.

Badgers and allies (Mustelidae)

Honey Badger was confirmed by camera-trapping at only one location – a den site – on the eastern slope of Mt Jideh, in closed-canopy forest close to a stream. This specific site was chosen after the author encountered the burrow by chance (Fig. 3), and shone a torch down it. This elicited a series of fierce rattling growls, which is typical defensive behaviour of Honey Badger. Forest-dwelling individuals in Central Africa have been



Fig. 3. Honey Badger *Mellivora capensis* den, Putu Iron Ore Mining concession, Liberia.



Fig. 4. Honey Badger *Mellivora capensis* social behaviour (olfactory communication), Putu Iron Ore Mining concession, Liberia.

reported as being all black (Hunter & Barrett 2011, Bahaa-eldin *et al.* 2013): this was apparent in the images (Fig. 4).

Twenty-six images were captured of these animals near the den between December 2010 and April 2011. Fifteen of the 26 images were taken after 06h00 hours and two images were taken after 09h00 (with the latest image recorded at 10h40). No activity was recorded again until after 17h00. Most images showed single individuals but three were of two. Five cases where single individuals were photographed were each followed within 30 minutes by another image of what was suspected, from size and appearance, to be a different individual, suggesting that these individuals were in association. A study of the images suggested that one relatively large adult male and two other adults were regularly using the den site. One of these adults was markedly smaller than the male and had a faint white patch or mantle on the top of its head. Because no male genitalia were captured on the images of this individual, it was presumably an adult female or possibly a sub-adult of either sex. The sex of the third adult could not be proposed. It was not possible to verify whether all images were of these three individuals, or whether additional individuals were using the den site. Other images showed African Brush-tailed Porcupine *Atherurus africanus* and bats using the den on days when the Honey Badgers were not photographed, so were presumed absent.

African Palm Civet (Nandiniidae)

Reflecting its nocturnal and arboreal nature, African Palm Civet *Nandinia binotata* was neither encountered on the recce survey nor camera-trapped. However, its species-typical vocalisation was heard in the forest at night, while the survey team camped within the concession, in areas of mature or re-colonising forest. In 2010, a dead, shot, individual was observed by the author in a village near the southern border of the concession, offered for roadside sale.

Civets and genets (Viverridae)

Occasionally, African Civet was seen on the PIOM roads at night. Its footprints ($n = 30$), however, were the most common small carnivore sign, and were regularly observed along these roads. While most footprints were observed in the Eastern Lowlands ($n = 13$) and Mt Jideh ($n = 13$), this was probably because of the predominance of roads there, rather than a natural preference for those areas. Thirty images at nine sites were recorded in all areas camera-trapped, suggesting that this species is widespread and common.

While arboreal in nature, genets may forage on the ground at night and occasionally small cat-like prints were encountered along roads. Only one species of genet, Bourlon's Genet *Genetta bourloni*, was identified from camera-trap images (P. Gaubert verbally 2011): the four confirmed images (e.g. Fig. 5) are believed to be the first photographs of wild-living individuals of this species. These images came from the PIOM ridgeline road on Mt Jideh in areas disturbed by mining exploration, on its western slope, in the Central Valley and on the ridgeline of Mt Ghi (Table 2). The species may thus be widely distributed at the site.

Discussion

In total, seven small carnivore species, representing four families, Viverridae (two species), Herpestidae (three species), Mustelidae

Table 2. Locations of Bourlon's Genet *Genetta bourloni* records, Putu Iron Ore Mining concession, Liberia.

Geographical area	Recce	Location	Date	Time
*Jideh western slope	12	5°20'22.959"N, 7°52'21.866"W	8 December 2010	08h37
Ghi ridgeline	6	5°18'18.828"N, 7°53'29.887"W	25 January 2011	06h13
Jideh PIOM road	11	5°20'06.927"N, 7°54'21.379"W	3 May 2011	05h11
Jideh PIOM ridgeline road	N/A	5°20'52.081"N, 7°52'11.125"W	5 May 2011	01h26
Central Valley	10	5°19'47.413"N, 7°53'39.735"W	24 May 2011	02h56

*Image of genet unidentified to species



Fig. 5. Bourlon's Genet *Genetta bourloni*, Putu Iron Ore Mining concession, Liberia.

(one species) and Nandiniidae (one species), were identified. Of particular note, the PIOM concession supports a population of the poorly-known, newly-described Bourlon's Genet: camera-trapping produced the first known images of wild-living individuals.

Moderate habitat disturbance may have a positive effect on some small carnivores such as mongooses, most of which are habitat generalists, such that some species are more abundant in rainforest fragments than in contiguous rainforest (Ray & Sunquist 2001). Slender Mongoose appears especially well adapted to disturbed and altered habitats. In West Africa, it is often observed in forest/cultivation mosaics and in oil palm concessions, and when crossing roads (EJG pers. obs.). Although Marsh Mongoose has a more selective diet (e.g. Ray & Sunquist 2001) it is also solitary, so may be better adapted to anthropogenic pressure than are more social species. It was camera-trapped both in disturbed habitats and in closed-canopy forest.

In contrast, Cusimanse is social and diurnal. Some (e.g. Davies 1990, Djagoun & Gaubert 2009) suggested it persists in a variety of habitats including farm bush, but others (e.g. Kingdon 1997) described it as largely restricted to lowland rainforest. In the PIOM concession, it was recorded only in closed-canopy forest.

Liberian Mongoose was not proven to occur. However, according to J. Cheflar, a mongoose matching its description was occasionally observed throughout the PIOM concession. These verbal reports suggest that even in the recent past, it was scarce in the study area. Its diet may be almost exclusively earthworms and insect larvae (Goldman & Taylor 1990), so lack of earthworms may exclude it from areas with hard laterite soils (Kingdon 1997), such as Mt Jideh. However, very little is known about this species. If it is a rainforest specialist, forest conversion and degradation in the site's lowlands over past decades may have driven a population decline. Its presence in nearby Sapu NP during concurrent camera-trapping

(Vogt *et al.* 2012) supports this suggestion, because Sapu NP has never been logged or legally commercially exploited. The status of Liberian Mongoose in the Putu Range has yet to be adequately assessed; it was camera-trapped in Sapu NP only after a survey effort of 4,500 camera-trap-days (Vogt *et al.* 2012), three times the effort invested into the present survey. The sites being contiguous, this mongoose may well occur in the Putu Range but as Liberia commercially exploits more of its forest, Sapu NP probably represents the only foreseeable hope for the species's survival in the absence of other protected areas and in light of its declining range (Taylor 1989).

Liberian Mongoose and Cusimanse, taxonomically related, share the same name in the local Krahn language, qualified by references to colour and to Liberian Mongoose's distinctive neck stripe. The same Krahn name is also given to a third kind of animal, stated to differ only in colour from Cusimanse. Colour variants in other mongoose species are known or suspected (e.g. Ross *et al.* 2012), so this local name potentially signifies a so-far undocumented colour morph.

No evidence of Gambian Mongoose *Mungos gambianus* was recorded. In common with most social species, except cusimanses and Liberian Mongoose, it lives in open habitats (Veron *et al.* 2004). Local knowledge suggests that it indeed does not occur here, but may be present further south in Sinoe County.

Although using a range of habitats, Honey Badger was not thought to inhabit rainforest until recently (e.g. Hoppe-Dominik 1990, Hancox 1992) and little is known about its status, behaviour and life-history in such habitat. Globally, Honey Badger populations are decreasing (IUCN 2012), so forest-dwelling populations may be of particular importance. Described as 'campers' with no fixed den site (Vanderhaar & Hwang 2003), multiple camera-trap photographs showed what were possibly the same individuals returning to a deep underground den over several months. Moreover, local hunters knew of this den site, suggesting long-term use. Thus, forest Honey Badgers may have traditional den sites, albeit using them intermittently.

Honey Badgers are typically nocturno-crepuscular, with increased daylight activity in cold weather (Hunter & Barrett 2011). These forest-dwelling individuals' morning activity may reflect forest habitats' greater cover and lower daytime temperatures than those in the more open habitats where this species has mostly been studied.

Honey Badgers were not recorded in any other region surveyed with camera-traps, although a lack of records does not imply absence. They may naturally occur at low density: they are solitary or pair-bonded foragers with extremely large overlapping ranges, and have low fecundity because of a long inter-birth interval and small litter size (Begg *et al.* 2005a, 2005b). However, the frequent use of this den by the individuals that used it suggests that suitable den sites may limit this species's distribution

in forests. It is not known to what extent commercial bushmeat hunting has reduced its population. It is rarely hunted, in part because it occurs at low density, but also because it is considered especially aggressive (the Liberian English name for a Honey Badger is a 'wolf'). Future mining of Mt Jideh may be detrimental to the local population, because this den site will be destroyed.

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