Conservation status, distribution and species richness of small carnivores in Africa

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Abstract

We assessed the global conservation status of small carnivores in Africa based on the *IUCN Red List of Threatened Species*. African small carnivores represent about 34% of extant small carnivores worldwide. Familial diversity is intermediate, with four of the world's nine families represented (Herpestidae: 47% of African species; Mustelidae: 20%; Nandiniidae: 2%; and Viverridae: 31%). Greatest species richness is recorded in equatorial Africa, although most sub-Saharan countries host at least 15 species (with a maximum of 26 in any one country). Of the 55 small carnivore species found in Africa, 51 (93%) are predominantly distributed in Africa and 48 (87%) are endemic. In terms of *IUCN Red List* conservation status, 43 species are Least Concern (LC), three are Near Threatened (NT), four are Vulnerable (VU) and five are Data Deficient (DD). No African small carnivore species is currently listed as Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) or Extinct (EX). For data-sufficient small carnivore species (i.e. non-DD), 8% were considered threatened (all VU), primarily a result of population declines and small distribution ranges (encompassing only 2–6 countries). The exact percentage of threatened species is unknown, but is between 7% (if no DD species is threatened) and 16% (if all are). Population trends are adjudged unknown for 46% of the species, while 27% are thought stable and 27% are believed decreasing. Compared with mammals worldwide, the overall conservation status of small carnivores in Africa appears relatively favourable. However, declining populations of many species and existing (habitat loss, degradation and fragmentation; exploitation for meat) and new threats (rapid economic development expanding the wild meat market, possibly to Asia) hint that additional small carnivore species may become threatened unless effective conservation strategies are implemented. This is of prime importance considering that over a quarter of the world's small carnivore species are endemic to Africa. Actions to remove or mitigate factors threatening Vulnerable and Near Threatened species constitute the short-term priority for small carnivore conservation in Africa.

Keywords: conservation status, Data Deficient, Herpestidae, *IUCN Red List*, Least Concern, Mustelidae, Nandiniidae, Near Threatened, population trends, species richness, Viverridae, Vulnerable

Statut de conservation, répartition et richesse spécifique des petits carnivores en Afrique

Résumé

Nous avons évalué l'état de conservation global des petits carnivores en Afrique en utilisant la *Liste Rouge des Espèces Menacées de l'UICN*. Les petits carnivores africains représentent environ 34% des petits carnivores existant à travers le monde. La diversité familiale est intermédiaire, avec quatre des neufs familles de la planète représentées (Herpestidae: 47% des espèces africaines; Mustelidae: 20%; Nandiniidae: 2%, et Viverridae: 31%). La plus grande richesse en espèces est enregistrée en Afrique équatoriale, bien que la plupart des pays d'Afrique subsaharienne hébergent au moins 15 espèces (avec un maximum de 26 dans un même pays). Sur les 55 espèces de petits carnivores qui se trouvent sur le continent africain, 51 (93%) sont essentiellement distribuées en Afrique et 48 (87%) sont endémiques. En ce qui concerne leurs statuts de conservation sur la *Liste Rouge de l'UICN*, 43 espèces sont dans la catégorie « Préoccupation mineure » (LC), trois sont « Quasi menacé » (NT), quatre sont « Vulnérable » (VU) et cinq sont classées dans la catégorie « Données insuffisantes » (DD). Aucune espèce de petits carnivore n'est actuellement considérée « En danger » (EN), « En danger critique » (CR), « Éteint à l'état sauvage » (EW) ou « Éteint » (EX). Parmi les espèces de petits carnivores pour lesquelles il existe des données suffisantes afin de leur attribuer un statut, 8% ont été considérées comme menacées (toutes VU), principalement en raison du déclin des populations concernées et de leurs aires de répartition géographique réduites (incluant seulement de 2–6 pays). Le pourcentage exact d'espèces menacées est inconnu, mais il est compris entre 7% (si aucune espèce DD n'est menacée) et 16% (si toutes le sont). Les tendances démographiques sont adjugées inconnues pour 46% des espèces, tandis que 27% sont considérées stables et 27% sont estimées être en baisse. Par rapport aux mammifères à travers le monde, le statut général de conservation des petits carnivores en Afrique semble relativement favorable. Toutefois, le déclin des populations de nombreuses espèces et les menaces existantes (perte, dégradation et fragmentation de l'habitat; exploitation pour la viande) et les nouvelles menaces (développement économique rapide entraînant une expansion du marché de la viande sauvage, peut-être jusqu'en Asie) laissent entendre que d'autres espèces de petits carnivores pourraient devenir menacées à moins que des stratégies de conservation efficaces soient mises en œuvre. Ceci est d'une importance primordiale étant donné que plus d'un quart des espèces de petits carnivores du monde sont endémiques à l'Afrique. Des actions pour éliminer ou atténuer les facteurs menaçant les espèces « Vulnérable » et « Quasi menacé » constituent la priorité à court terme pour la conservation des petits carnivores en Afrique.

Mots clés: « Données insuffisantes », Herpestidae, *Liste Rouge de l'UICN*, Mustelidae, Nandiniidae, « Préoccupation mineure », « Quasi menacé », richesse spécifique, statut de conservation, tendances démographiques, Viverridae, « Vulnérable »

Introduction

Encompassing nearly 30.3 million km^2 or 20% of the Earth's land surface, Africa represents the second largest continent and one of the oldest and most geologically stable land masses on Earth, existing in continental form for at least 3,800 million years of Earth's history (Schlüter 2008). Spanning the Equator, Africa is the only continent to occupy both northern and southern temperate zones (O'Brien & Peters 1999). Latitude ranges from 37°20′N in Tunisia to 34°50′S along South Africa's Cape region, longitude of the mainland from 17°31′W in Dakar, Senegal, to 51°25′E in coastal Somalia. With the exception of the Atlas Mountains, running from southwestern Morocco along the Mediterranean coastline to the eastern edge of Tunisia, northern Africa is dominated by the world's largest desert: the Sahara Desert covers approximately 9 million km^2, nearly 30% of continental Africa. In the east, the Great Rift Valley, a massive depression bordered by numerous mountain chains, runs from northern Syria to central Mozambique. The world's longest river, the Nile, flows northward through the Sahara, intersecting 10 African countries and running over 6,695 km from its origin in Rwanda (Liu *et al.* 2009) to its mouth along Egypt's Mediterranean coastline (Reader 1997). The Sahel, a broad expanse of semi-arid grasslands spanning the southern edge of the Sahara Desert, separates the dry deserts of North Africa from the tropical Sudanian Savannah of north-central Africa. Bordering the eastern limits of the Sahel are the Ethiopian Highlands, a contiguous region where altitude rarely falls below 1,500 m. Two major rivers, the Niger in the west and the Congo in Central Africa, help to shape the tropical forests of west-central Africa. Spanning more than 4,000 km, the Congo forms the second largest river basin in the world, covering nearly 3.7 million km^2 across seven countries (Reader 1997). South of the Central African rainforests lie the miombo woodlands, a broad belt of wooded savannah running west from Angola into eastern Tanzania (Le Houérou 2009). The Southern African Subregion, south of the Kunene and Zambezi Rivers, is dominated by the Kalahari and Namib Deserts which cover most of Botswana (excepting the Okavango Delta and northern miombo woodlands) and Namibia. Additional ecoregions include the Karoo of South Africa; the bushveld of eastern Botswana, South Africa and Zimbabwe; and the Zambezian and mopane woodlands of southeast Africa. These diverse ecoregions, delimited by distinct bioclimatic parameters such as soil types, climate and vegetation (Le Houérou 2009), combined with historical geomorphological changes, climatic oscillations, colonisation patterns and *in situ* evolution have all helped shape Africa's modern mammal community (Sanders & Werdelin 2010). Supporting 1,161 mammal species in 16 orders (Kingdon *et al*. 2013), nearly a quarter of all living mammals, Africa is second only to the Neotropics (with 1,282 species) in overall mammal species richness (Mace *et al.* 2005). However, local African mammal communities tend to hold more species than their Neotropical counterparts, despite similarities in area, latitudinal position, landscapes and regional species pools (Vivo & Carmignotto 2004, Nieto *et al*. 2005), often attributable to differences in abundance of medium to large species (Cristoffer & Peres 2003, Vivo & Carmignotto 2004, Nieto *et al*. 2005). Unfortunately, Africa's mammalian communities currently face extreme threats from one species in particular, *Homo sapiens*. Approximately 15% (1.05 US billion) of the estimated global human population (6.97 US billion) live in Africa (UN 2011). People exert local, regional and national pressure on wildlife populations, especially mammals of medium to large size (i.e. >3 kg; Cardillo *et al.* 2005), often enhancing their risk of extinction.

Because of their size, often diurnal habits and economic value (e.g. food and tourism, including hunting), many large African mammals have been subjected to considerable fundamental (see Kingdon *et al.* 2013) and applied research, primarily serving the purposes of the wildlife industry (see Bothma & du Toit 2010). Among those species, large African carnivores have drawn considerable attention from researchers (and conservation organisations), initially through their charisma but also for their potential for conflicts and the resulting threats to several species and populations (Gittleman *et al.* 2001). Large carnivores are important in regulating land and aquatic ecosystems (Estes *et al.* 2011) through cascading interactions across trophic levels (Steneck 2005, Terborgh & Estes 2010). Small carnivores, on the other hand, although more species-rich and generally more common, are mistakenly thought to have a lower impact at the ecosystem level (Roemer *et al.* 2009). Indeed, although their impacts are not on the same guild of prey as large carnivores, small carnivores are similarly important ecosystem regulators through structuring small mammal and/or invertebrate communities (Virgós *et al.* 1999), which in turn might affect higher trophic levels. They may also be important in seed dispersal, affecting plant gene flow or ecology (Herrera 1989, Jordano *et al*. 2007, Nakashima & Sukor 2009, Mudappa *et al*. 2010). Possible roles of small carnivores in shaping ecosystems have also been shown accidently through introductions. For example, American Minks *Neovison vison* introduced to Europe can cause a shift in bird breeding sites (Nordström & Korpimäki 2004) and compete with local species (Harrington & Macdonald 2008). There are similar examples of important ecological impacts from introduced species in several families of land Carnivora that contain small to mid-sized species (Roemer *et al.* 2009). Finally, where larger carnivores are exterminated by humans (directly or through habitat change), small carnivores have or may become *de facto* apex predators in these ecosystems (Crooks & Soulé 1999, Roemer *et al.* 2009), potentially altering their ecological roles and importance in such systems.

In Africa, only some of the diurnal, social small carnivore species, specifically Meerkat *Suricata suricatta* (see back cover), Banded Mongoose *Mungos mungo*, Common Dwarf Mongoose *Helogale parvula* and Yellow Mongoose *Cynictis penicillata* (see cover), have been extensively studied. All others, including the widely distributed Common Slender Mongoose *Herpestes sanguineus* (Fig. 1), have received limited attention. Hence, with few exceptions, the behaviour and ecology, and therefore the ecological role, of most African small carnivore species remain unknown. The conservation status of all mammals worldwide was assessed for the 2008 *IUCN Red List of Threatened Species* (Schipper *et al.* 2008b) and results were summarised for small carnivores globally (Schipper *et al.* 2008a) as well as in the Americas (Belant *et al.* 2009). Here, we report on the conservation status, distribution and species richness of small carnivores (Herpestidae, Mustelidae, Nandiniidae and Viverridae) in Africa.

Fig. 1. Common Slender Mongoose *Herpestes sanguineus* (here two juveniles in Kruger National Park, South Africa) is one of the most widespread and commonly seen mongooses in Africa. Yet, little is known about its behavioural ecology (Photo: E. Do Linh San).

Methods

Methods to assess the conservation status of the world's mammals through the Global Mammal Assessment in 2008 were reported by Schipper *et al.* (2008a, 2008b). Contrary to previous mammal *IUCN Red List* assessments, that in 2008 used an expert review process. General information was gathered on distribution, population size and trends, habitat use, ecology, threats and conservation actions for each species. A digital map of the geographic range of each species was also developed in a Geographic Information System. Supporting information for most African species was reviewed during the Old World Small Carnivore Red List Assessment workshop in Cuc Phuong National Park, Viet Nam, from 3 to 7 July 2006, and a preliminary assessment of the *IUCN Red List* status of these species was made using the *IUCN Red List Categories and Criteria version 3.1*. The remaining species were assessed and reviewed through email correspondence with experts. Finally, the Red List Authority Coordinators of the IUCN Species Survival Commission (SCC) Small Carnivore Specialist Group (SCSG) and the IUCN SCC Otter Specialist Group (OSG) reviewed the assessments. The former covers weasels and allies except otters (Mustelidae except Lutrinae), African Palm Civet (Nandiniidae), civets and allies (Viverridae) and mongooses (Herpestidae); the latter treats otters (Mustelidae: Lutrinae).

We defined small carnivores as species within the remits of the SCSG and OSG, and took the Suez Canal as the eastern boundary of Africa. We therefore do not consider Marbled Polecat *Vormela peregusna*, a Eurasian species recently discovered to inhabit the Sinai Peninsula of Egypt (Saleh & Basuony 1998), part of the African fauna. Madagascar was similarly excluded; no species, or even family, of carnivores is native to both Africa and Madagascar (Goodman 2012). Analysis and discussion treats only species native to Africa, including (pending further clarification) two species, both confined in mainland Africa to the north, for which origin in Africa is not clear. Contemporary research points to an anthropogenic introduction for Least Weasel *Mustela nivalis* (Dobson 1998, Lebarbenchon *et al.* 2010), but animals taxonomically close to Western Polecat *M. putorius* are speculated to be native (Gippoliti 2011, Ahmim 2013). Several mainland species occur on African islands, either naturally or through human transport (Appendix 2). Several non-African species have also been introduced to various African islands. These species are not included in analyses and discussion. As examples, Small Indian Civet *Viverricula indica* is found on Unguja, Pemba and Mafia Islands (Pakenham 1984, Kock & Stanley 2009) and Small Asian Mongoose *Herpestes javanicus* on Mafia Island (Kock & Stanley 2009). There seem to be no non-native small carnivores established in mainland Africa. Analyses of distributional and species-richness patterns cover only the countries of mainland Africa. Thus, the Macaronesian islands (various countries) and the island nation of Sao Tome and Principe were excluded. None of these archipelagos is believed to support native small carnivores (Appendix 2). These country-based analyses also ignore the two European exclaves in mainland Africa, Ceuta and Melilla (Spain; total 30.8 km^2); we traced no information on which small carnivore species these support.

The classification for African small carnivores on the *IUCN Red List* (see Appendix 1) currently largely follows Wozencraft (2005), although Sokoke Dog Mongoose *Bdeogale omnivora* and Congo Clawless Otter *Aonyx congicus* were considered conspecific with Bushy-tailed Mongoose *B. crassicauda* and African Clawless Otter *Aonyx capensis*, respectively, by Wozencraft (2005). The many points of taxonomic uncertainty with African small carnivores mean that the species count presented in this paper (n = 55) is sure to change, perhaps substantially, with further research involving both molecular techniques and morphological analyses. For example, South African Small-spotted Genet *Genetta felina* (Fig. 2) is now widely recognised as distinct (e.g. Gaubert *et al.* 2004, 2005, Jennings & Veron 2009) although not universally so (e.g. Delibes & Gaubert 2013, IUCN 2013) and, following the latter, is here considered conspecific with Common Genet *G. genetta*. *IUCN Red List* status and population trend information for each species refers to its global status, not to its status specific to Africa (some species also occur outside Africa; Appendix 1). Some data used in this paper are freely available online (IUCN 2013).

Fig. 2. South African Small-spotted Genet *Genetta (genetta) felina* (here one radio-collared individual from Great Fish River Reserve, South Africa) is now often treated as a species (Photo: E. Do Linh San).

In this study, species richness was defined as 1) the number of small carnivore species here assessed as occurring naturally in each of the 48 mainland African countries, and 2) species density, the number of species per 100,000 km^2 of country (see Appendix ES1). Species lists for each country were compiled from several sources (Appendix 1), including extensions of known range described in this special issue of *Small Carnivore Conservation*. Sudan and South Sudan are treated as a single unit, because most references did not differentiate between the former Southern Sudan autonomous region (which became a country in 2011) and the residual Sudan in terms of species presence or absence. We used Generalized Linear Models (GzLMs) to test whether species threat level is associated with the extent of species distribution, expressed as the number of countries in which each species is indicated to occur by these sources, or its range area as in the *IUCN Red List*. For this purpose, *IUCN Red List* categories were converted to an ordinal scale according to an increasing threat level (Least Concern = 1, Near Threatened = 2, Vulnerable = 3). The five Data Deficient species and the three species with only a small proportion of their world range in Africa (see Appendix 1) were excluded from analyses. A multinomial distribution and a cumulative logit function were used to generate GzLMs, and the finite sample corrected Aikaike's Information Criterion (AICc) was used to compare the models (Norušis 2008). Potential significant differences between threat level categories were further tested with Mann-Whitney *U* tests. Similarly, we tested whether species richness is affected by four possible predictors (or covariates) reflecting country size, human density and societal development: country area (km^2), number of inhabitants/km^2, gross national product (GNP) per inhabitant (US$) and gross domestic product (GDP) per inhabitant (US$) (raw data in Appendix ES1). Negative binomial distributions and log link functions were used for the count variable (absolute species number), whereas gamma distributions and power functions were used to model the continuous variable (average number of species per 100,000 km^2 of country). For the negative binomial distributions, the dispersion parameter k was set at 0.1. The ratio of the deviance to its degree of freedom was close to 1 for the response variable in all the models, indicating that the variability in observed data was similar to that predicted by the underlying distributions used for the models (Norušis 2008). Before conducting GzLMs, we assessed multicollinearity of predictor variables using Spearman rank correlation; variables considered highly correlated ($r_S > 0.3$, $P < 0.05$) were not included in the same models. As suggested by Norušis (2008), in all GzLMs the scale parameter was estimated by dividing the deviance by its degrees of freedom. The possible effects of independent variables were evaluated with a Type III test, which does not depend on the entry order of variables (Norušis 2008). The significance level for all analyses was set at $\alpha < 0.05$.

Results

Under the *IUCN Red List*'s taxonomy, four families of small carnivores occur partly or entirely (Nandiniidae; monospecific) in Africa, encompassing 23 genera and 55 species. The most speciose family in Africa is Herpestidae (26 species, 47% of African small carnivore species), followed by Viverridae (17 species, 31%) and Mustelidae (11 species, 20%). On average, mainland African countries contain 15 (SD = 5.5) small carnivore species (Table 1). Countries of greatest species richness occur in equatorial Africa (countries roughly within 15° of the Equator) although most sub-Saharan countries hold more than 15 species (Fig. 3; Appendix ES1). Lowest per-country species richness is in North Africa. The pattern is somewhat different when using each country's species density as an index. On average, each country contains 13.5 (SD = 24) species per 100,000 km^2 of its area (Table 1). Figure 3 (right map) shows that several small African countries (The Gambia, Guinea Bissau, Sierra Leone, Liberia, Togo, Benin, Equatorial Guinea, Eritrea, Djibouti, Rwanda, Burundi, Malawi, Swaziland, Lesotho) host more species per unit area of country than do larger, neighbouring countries. This is because the calculated country-specific species density is affected by both true species richness per 100,000 km^2 (i.e. the number of species per 100,000 km^2 block, irrespective of country boundaries) and by country size (i.e. the size of the block used to derive the country-specific species density). However, species density is again lower in North Africa. Most countries fall on or very close to the indicated power regression curve (Fig. 4), suggesting that most of the variation in this character stems from a basic relationship of species richness increasing with country area, but not in linear proportion. However, two countries (Western Sahara and Tunisia) lie noticeably below the curve, indicating that these countries (both dominated by poorly-vegetated arid habitats) support anomalously few species for their area. Perhaps surprisingly, no country supports an unexpectedly large number

Table 1. Small carnivore species richness and density in mainland African countries and size, demographic and socio-economic characteristics of those countries.

	n	Average	Standard deviation	Minimum	Maximum
Species per country[1]	48	14.92	5.61	3	26
Species density[2]	48	13.56	24.06	0.17	134.87
Country area (km²)	48	579,996	584,636	10,380	2,381,740
Number of inhabitants/km²	48	74.22	95.36	2.04	448.26
GNP[3]/inhabitant (US$)	47[3]	969	1,308	66	5,398
GDP[3]/inhabitant (US$)	47[3]	2,729	4,906	231	29,332

[1]The two countries Sudan and South Sudan are treated as one unit; countries with only island and/or exclave territory in Africa are omitted (see text).
[2]Number of species per 100,000 km² of a country.
[3]GNP = Gross National Product, GDP = Gross Domestic Product; no data were available for Western Sahara. Data country by country are provided in Appendix ES1.

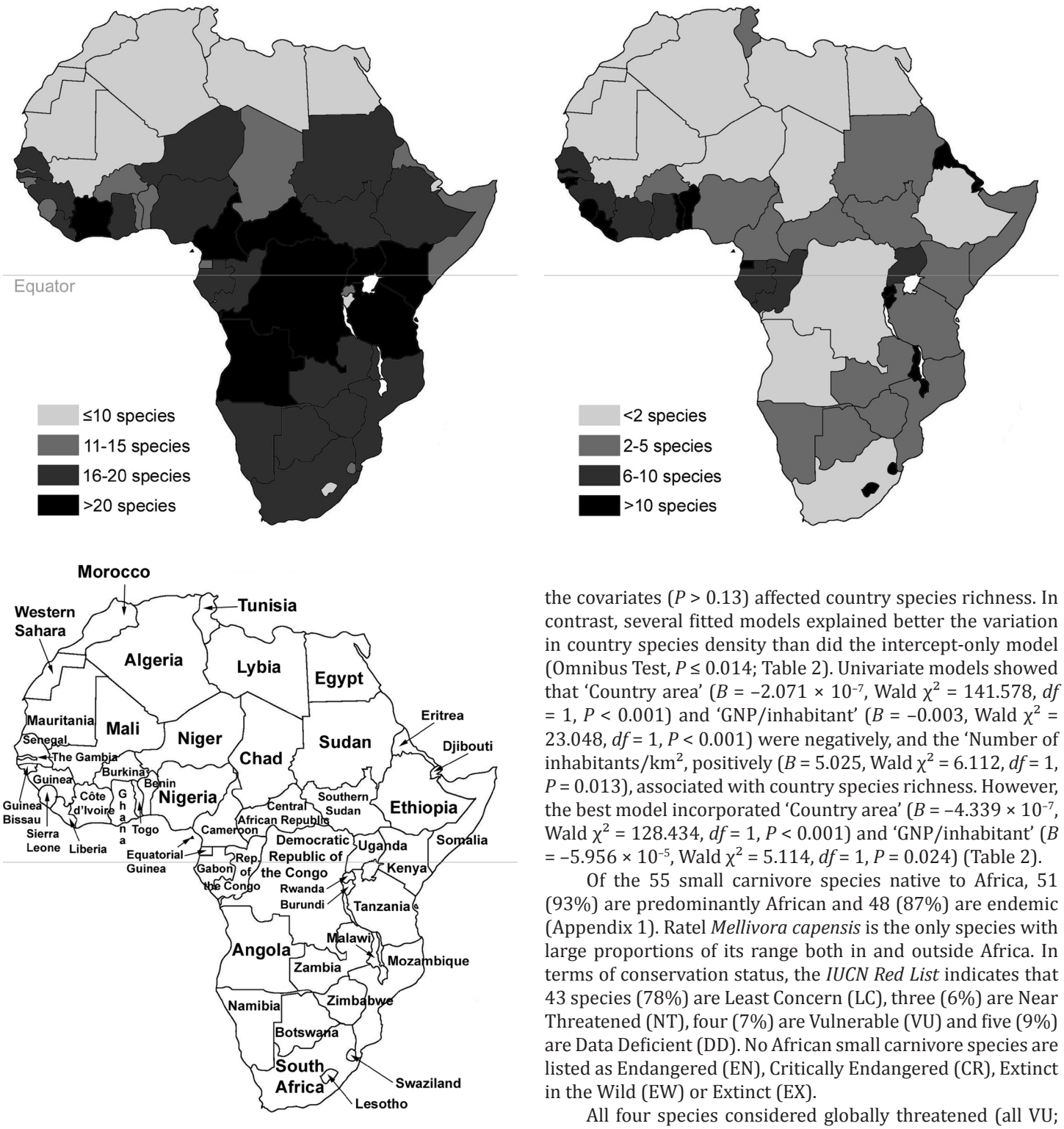

Fig. 3. Country-based species richness of small carnivores in continental Africa based on the *IUCN Red List* and overview and location of mainland African countries (countries with only island territory in Africa were not included in the comparison; and Sudan and South Sudan were treated as one unit). Left: species richness per country; right: species density, i.e. number of species per 100,000 km² of country.

of species for its area. The results of the GzLM procedure indicated that the intercept-only model had a greater explanatory power (Omnibus Test, $P > 0.13$) than the fitted models including different combinations of predictors; hence, none of the covariates ($P > 0.13$) affected country species richness. In contrast, several fitted models explained better the variation in country species density than did the intercept-only model (Omnibus Test, $P \leq 0.014$; Table 2). Univariate models showed that 'Country area' ($B = -2.071 \times 10^{-7}$, Wald $\chi^2 = 141.578$, $df = 1$, $P < 0.001$) and 'GNP/inhabitant' ($B = -0.003$, Wald $\chi^2 = 23.048$, $df = 1$, $P < 0.001$) were negatively, and the 'Number of inhabitants/km^2, positively ($B = 5.025$, Wald $\chi^2 = 6.112$, $df = 1$, $P = 0.013$), associated with country species richness. However, the best model incorporated 'Country area' ($B = -4.339 \times 10^{-7}$, Wald $\chi^2 = 128.434$, $df = 1$, $P < 0.001$) and 'GNP/inhabitant' ($B = -5.956 \times 10^{-5}$, Wald $\chi^2 = 5.114$, $df = 1$, $P = 0.024$) (Table 2).

Of the 55 small carnivore species native to Africa, 51 (93%) are predominantly African and 48 (87%) are endemic (Appendix 1). Ratel *Mellivora capensis* is the only species with large proportions of its range both in and outside Africa. In terms of conservation status, the *IUCN Red List* indicates that 43 species (78%) are Least Concern (LC), three (6%) are Near Threatened (NT), four (7%) are Vulnerable (VU) and five (9%) are Data Deficient (DD). No African small carnivore species are listed as Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) or Extinct (EX).

All four species considered globally threatened (all VU; Sokoke Dog Mongoose, Liberian Mongoose *Liberiictis kuhni*, Crested Genet *Genetta cristata* and Johnston's Genet *G. johnstoni*) were listed under the A Criterion (population decline) (Appendix 1). None was listed using the B Criterion (geographic range size), C Criterion (population size and decline), D Criterion (very small or restricted population) or E Criterion (quantitative analysis). Similarly, the three NT species (Jackson's Mongoose *Bdeogale jacksoni*, Bourlon's Genet *G. bourloni* and Eurasian Otter *Lutra lutra*) were listed using the A Criterion (Appendix 1). All threatened and two of the three NT small carnivore species are endemic to Africa, while Eurasian Otter is widespread across Eurasia (Appendix 1). While for

Table 2. Results of the GzLM procedures (Omnibus tests) testing the potential effects of country size (km²) and demographic and socio-economic characteristics on country-specific small carnivore species density, i.e. species richness per 100,000 km² of a country's area.

Variables in the alternative GzLMs	Power	Scale	LR χ^2	*df*	*P*	AICc
Country area, GNP/inhabitant	0.20	0.988	55.356	2	<0.001	292.714
Country area, GDP/inhabitant	0.14	1.000	54.178	2	<0.001	293.235
Country area	0.10	0.975	57.937	1	<0.001	294.046
Number of inhabitants/km²	2.20	1.549	19.426	1	<0.001	320.440
GNP/inhabitant	1.00	1.922	6.074	1	0.014	333.455
GDP/inhabitant	0.20	2.176	0.131	1	0.717	344.845

GzLM = Generalized Linear Model, LR = Likelihood Ratio, AICc = finite sample corrected Akaike's Information Criterion, GNP = Gross National Product (US$), GDP = Gross Domestic Product (US$).
Only models incorporating uncorrelated predictors were considered.

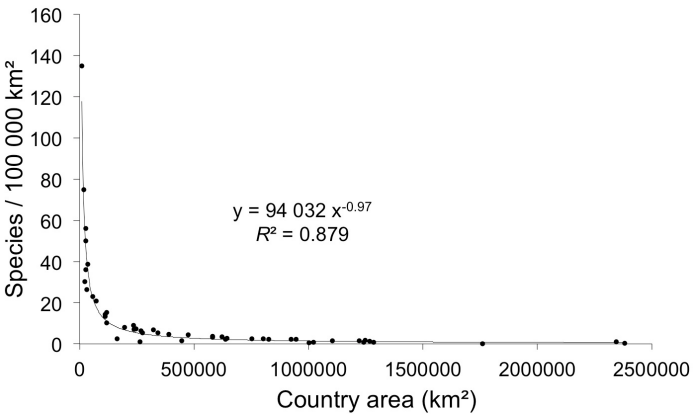

Fig. 4. The relation of country-based species density of small carnivores in continental Africa with country area. Line represents a fitted power function regression curve.

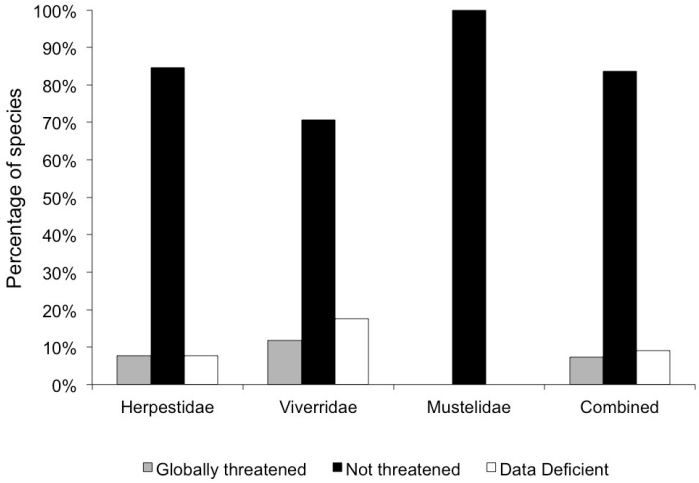

Fig. 5. Threat levels of small carnivore species by family in Africa based on the *IUCN Red List*. The family Nandiniidae, monospecific (LC), is not displayed but has been taken into account in the overall evaluation (category 'Combined'). Note that Near Threatened is a category of 'not threatened', not of 'globally threatened'.

data-sufficient small carnivore species, 8% were considered threatened (Fig. 5), the exact threat level is between 7% (if no DD species is threatened) and 16% (if all are).

As could be expected, the range area and the number of countries in which each African small carnivore species occur are highly positively correlated (Spearman rank correlation, $r_S = 0.915$, $P < 0.001$). The GzLM procedure indicated that 'Range area' is negatively associated with an increase in small carnivore threat level ($B = -9.36 \times 10^{-6}$, Wald $\chi^2 = 17.727$, $df = 1$, $P < 0.001$, AICc = 26.708). A model integrating 'Number of countries' even had a slightly better explanatory power, with an increase in the number of countries being linked to a decrease in species threat level ($B = -0.383$, Wald $\chi^2 = 17.258$, $df = 1$, $P < 0.001$, AICc = 23.721). Vulnerable and Near Threatened small carnivores have typically more restricted ranges than Least Concern species (Table 3). Overall, Least Concern species occur in more countries (Mann-Whitney *U* test, $n_1 = 43$, $n_2 = 7$, $U = 59$, $P = 0.009$) and have larger geographic ranges ($n_1 = 41$, $n_2 = 6$, $U = 7$, $P < 0.001$) than do Vulnerable and Near Threatened species combined. Data Deficient species possess even more restricted distribution ranges than do threatened species (Table 3).

The percentage of species considered globally threatened varies across families, from 0% (Mustelidae and Nandiniidae) to about 8% in Herpestidae and 12% in Viverridae (Fig. 5). There are no DD species in the family Mustelidae, in contrast to about 8% of species of Herpestidae and 18% of Viverridae being so classified (Fig. 5). The geographic distribution of DD species includes equatorial African countries (Côte d'Ivoire, Liberia, Ghana, Equatorial Guinea, Republic of Congo, Central African Republic, Uganda and Democratic Republic of Congo), as well as Angola and Sudan. Treating only data-sufficient species, the percentage of threatened species increases slightly to 14% for Viverridae, while remaining 8% for Herpestidae.

Overall, population trends for 46% ($n = 25$) of small carnivore species in Africa are assessed as unknown globally, including 27% of species of Mustelidae, 35% of Herpestidae and 71% of Viverridae (Fig. 6). Of the 30 species with assessed population trends, 50% (27% of species overall) are believed to be stable and 50% (27%) to be decreasing; none is thought to be increasing.

Discussion

Small carnivores in Africa represent 34% of the extant small carnivores worldwide ($n = 163$ species; Schipper *et al.* 2008a). Familial richness is intermediate, with four of the world's nine families represented (Ailuridae, Eupleridae, Mephitidae, Procyonidae and Prionodontidae are all extralimital). Country species richness was not affected by country size, human population density or by coarse-scale socio-economic indices. At first glance, greatest species richness of small carnivores

Table 3. Distribution of small carnivores in Africa, compared based on their *IUCN Red List* category.

***Red List* category**	**Number of species[1] in Africa**	**Number of mainland countries per species**			
		Mean	**Standard deviation**	**Minimum**	**Maximum**
LC	43	15.72	14.40	1	44
NT	3	3.33	0.58	3	4
VU	4	3.75	1.71	2	6
DD	5	2.80	1.64	1	5
Total	**55**	**13.02**	**13.76**	**1**	**44**
***Red List* category**	**Number of species[2] in Africa**	**Geographic range area per species (km²)**			
		Mean	**Standard deviation**	**Minimum**	**Maximum**
LC	41	5,785,851	6,614,627	43,777	28,885,834
NT	2	105,408	58,626	63,953	146,863
VU	4	129,949	121,033	34,426	306,732
DD	5	298,473	236,848	49,336	602,126
Total	**52**	**4,604,671**	**6,294,881**	**34,426**	**28,885,834**

LC = Least Concern, NT = Near Threatened, VU = Vulnerable, DD = Data Deficient.
[1]Comparison considers all species of small carnivores occurring in Africa.
[2]Comparison omits the three species in Africa (*Mustela nivalis*, '*M. putorius*' and *Lutra lutra*) with ranges predominantly in other continents.

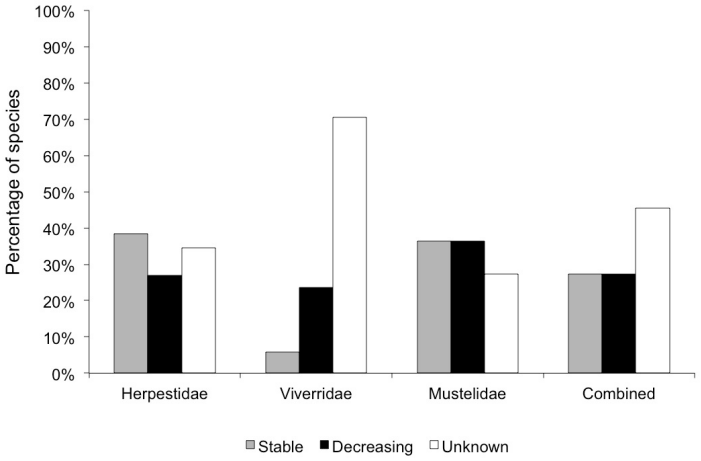

Fig. 6. Global population trends of small carnivore species by family in Africa based on the *IUCN Red List*. The family Nandiniidae, monospecific (unknown population trend), is not displayed but has been taken into account in the overall evaluation (category 'Combined').

in Africa seems to follow the general pattern of overall land mammal species richness (Schipper *et al.* 2008b) and of small carnivore species richness in the Americas (Belant *et al.* 2009), peaking in the tropics and therefore in areas of high ecological and possibly topographic complexity. Small carnivore species richness generally declines with increasing latitude (Belant *et al.* 2009). In Africa, small carnivore richness is indeed lower in the north, but not in the south, suggesting that the low productivity of the vast and arid Sahara might explain the observed difference. That country species density was markedly greater in smaller countries throughout Africa indicates that as country size increases, the number of 'new' habitats favourable to host additional, possibly more 'specialised' small carnivore species does not increase in proportion. These results support the notions that although some habitat size threshold might be essential to ensure population viability (e.g. Crawley & Haral 2001, Brito & Grelle 2006) and that the larger an area the more species generally it will hold (Ruggiero *et al.* 1994), area *per se* is not the only variable for explaining local patterns of mammalian species richness. For conservation purposes, other factors such as habitat diversity and species interactions should be taken into account when assessing species richness and diversity at the landscape scale (Fox & Fox 2000). Human population density was positively associated with country species richness. This could suggest that an increase in potential human population pressure might not necessarily be detrimental to small carnivores, at least for generalist species that are probably less sensitive to habitat change. However, it could as well indicate that areas productive for people, and thus supporting higher human population densities, are also inherently rich in small carnivore species. If indeed so, this might mean that species-rich small carnivore communities are more likely to be threatened by, or in conflict with, humans. This situation would add to conservation challenges. Precise data on small carnivore species compositions and densities in human-populated areas would be needed for firm conclusions.

Based on extinction risk as measured by the *IUCN Red List*, small carnivore species in Africa appear more secure than small carnivores or mammals globally. However, this comparison requires a caveat. Assessments of species status always contain some degree of uncertainty and the particularly low levels of knowledge for many African species mean that they are at elevated risk of incorrect assessment. That said, 'only' 8% of data-sufficient African small carnivores were assessed as globally threatened, compared with 20% in the Americas (Belant *et al.* 2009) and 22% worldwide (Schipper *et al.* 2008a). Overall, 25% of all mammals worldwide are consid-

ered globally threatened (Schipper *et al.* 2008b). In Africa, the four globally threatened (in this case Vulnerable) and two of the Near Threatened species were listed as such by the *IUCN Red List* based on an estimated population decline. Most African small carnivores have distribution ranges that well exceed the thresholds for listing under the B criterion. However, an increase in threat levels is associated with a decrease in range areas (see above). All five DD species have extremely small ranges and considering the likely threats to such species (see below), the comparatively low threat levels to African small carnivores provided above should be interpreted with caution. In addition, even some LC species would benefit from clarification of conservation status.

Threats to the globally threatened African small carnivores vary between species. Sokoke Dog Mongoose, restricted to coastal forests of Kenya and Tanzania, is believed to have declined substantially through impacts of extensive, ongoing habitat loss related to illegal logging (Taylor 2013). In the Shimba Hills National Reserve (Kenya), the resident population was, and might still be, under potential threat from afforestation with non-native pines *Pinus* together with regular burning of the undergrowth to favour Sable Antelope *Hippotragus niger grazing* (Engel & Van Rompaey 1995). In West Africa, both Liberian Mongoose and Johnston's Genet lose habitat to agriculture, logging and mining within their Upper Guinea forests ranges, and are hunted (mostly for meat and skin) with dogs, shotguns and snares (Dunham & Gaubert 2013, IUCN 2013). The lack of den sites in secondary forests might restrict Liberian Mongoose distribution, while in forest plantations this species might also suffer from pesticide use, because the worms it forages on accumulate toxins to levels threatening to mammalian predators (Taylor & Dunham 2013). For Crested Genet, endemic to Nigeria and Cameroon, and perhaps the Republic of Congo and Gabon (Hunter & Barrett 2011), habitat loss is probably also a major threat (Gaubert *et al.* 2006), because the non-protected Cross River State forests (Nigeria) are gradually being converted into farms or wastelands and the Niger Delta is exploited as an oil-production area (Angelici & Luiselli 2005). It probably also suffers from high hunting pressure (Van Rompaey & Colyn 2013a).

Among the Near Threatened species, little is known about threats to Eurasian Otter in its limited African range (Algeria, Morocco and Tunisia). These populations have shown little sign of recovery, unlike those in parts of Europe. In Morocco, pollution has increased dramatically in the major rivers, especially in the north, where otters have apparently disappeared from rivers in the lowland plains, and dam building has also reduced habitat and fragmented populations (Delibes *et al*. 2012, Kruuk 2013). Jackson's Mongoose is thought to have declined by 20–25% over the 15 years preceding the *IUCN Red List* assessment (IUCN 2013). Its probable dependence on forest means its main threat is likely to be ongoing clearance at the restricted number of sites in Uganda, Kenya and Tanzania it occupies (Van Rompaey & Kingdon 2013). Protection of such forests is crucial, and other East African groundwater-dependent forests should be surveyed for Jackson's Mongoose (De Luca & Rovero 2006). Bourlon's Genet is essentially restricted to the Upper Guinean rainforests (see countries in Appendix ES1) and is believed to have declined by more than 20% over the 20 years prior to 2008 based on estimates of ongoing forest loss (although not as severe in Liberia, the core of the species's range, as elsewhere in Upper Guinea; Papeş & Gaubert 2007), coupled with the likely impacts of hunting (IUCN 2013). All Vulnerable and Near Threatened small carnivore species are in need of further survey work to clarify their conservation status (distribution and population density/trends) in the wild, and also, when relevant, to determine sustainable levels of offtake from the wild and general management and conservation measures.

The percentage of small carnivores in Africa with inadequate data to assess conservation status (i.e. Data Deficient; 9%) is similar to that of small carnivores in the Americas (11%; Belant *et al.* 2009) and worldwide (9%; Schipper *et al.* 2008a), and slightly lower than the percentage of such land mammals overall (15%; Schipper *et al.* 2008b). Categorising a species as Data Deficient means that insufficient information is available to evaluate ongoing threats and/or there is serious doubt that species rank is taxonomically appropriate. Taxonomic uncertainty does not drive the DD listing for any of the five African small carnivores so categorised. Pousargues's Mongoose *Dologale dybowskii* is perhaps the least known African small carnivore: known from only 31 specimens, it has not been conclusively recorded in several decades (Stuart & Stuart 2013; but see Aebischer *et al*. 2013). Aquatic Genet *Genetta piscivora* from Democratic Republic of Congo is also poorly known, rarely observed, and taken as bushmeat (Van Rompaey & Colyn 2013b); it may possibly warrant listing under criteria A or C. The taxonomically recently resurrected King Genet *G. poensis* has a disjunct distribution in forest from Liberia to Republic of Congo and although not reliably recorded for over 50 years, this likely reflects confusion with other genets, so it may well be more common than it seems (Gaubert 2003, 2013). West African Oyan *Poiana leightoni* has a very narrow distribution in the upper Guinean forests (Van Rompaey & Colyn 2013c), and may have a status akin to that of other co-occurring species with similar narrow ranges, such as Johnston's Genet (VU) and Liberian Mongoose (VU). Finally, Ansorge's Cusimanse *Crossarchus ansorgei* from Central Africa is poorly known (Van Rompaey & Colyn 2013e), but likely to be listed as Least Concern with further information (IUCN 2013). Only further research and survey work can clarify the population status, trends and threats of these species. These Data Deficient species occur primarily in equatorial Africa, making this one region where investigation and research efforts should be concentrated.

Finally, populations of mainland species on islands might be worth investigating in further detail, especially endemic subspecies perhaps under threat. In Zanzibar, Goldman & Winther-Hansen (2003) mentioned three such endemic subspecies: Servaline Genet *Genetta servalina archeri*, Common Slender Mongoose *Herpestes sanguineus rufescens* and Bushy-tailed Mongoose *Bdeogale crassicauda tenuis*.

The overall assessed conservation status of African small carnivores is relatively favourable compared with mammals worldwide. However, the four Vulnerable and three Near Threatened species warrant specific interventions to ensure their persistence, yet for none does there seem to be a conservation programme in place to remove and/or mitigate the

factors threatening it. Effective action for these species is the short-term priority for small carnivore conservation in Africa. In future the threat levels of African small carnivores are likely to worsen. At least a quarter are assessed by IUCN (2013) as already in decline. All major threats originate from people, and with Africa having the highest human population growth rate of any continent (UN 2011), existing threats will surely intensify and probably diversify. The high demand for wildlife meat and other products in East Asia is not abating and already animals much declined in Asia are sourced from Africa to meet this demand (Bennett 2011). Small carnivores are a large part of Asian wildlife trade (e.g. Bell *et al*. 2004) and, as their Southeast Asian populations decline they are likely to join the trade from Africa to East Asia. Simultaneously, continued high levels of evergreen forest conversion and fragmentation are reducing habitat block size (Newmark 1998), meaning that the species of those habitats will become increasingly susceptible to hunting even if levels remain constant. Altogether, this suggests that additional African small carnivore species will meet globally threatened criteria if no effective conservation strategies are implemented, in particular to combat wildlife meat trade and illegal logging. Considering the paucity of information available on this fascinating group of species and the high level of endemism of small carnivores in Africa, both research and conservation will be of prime importance in the future.

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Additional material related to this paper* can be found as a PDF file (SCC48_Appendix-ES1.pdf) on the SCC website in the following link: http://www.smallcarnivoreconservation.org/home/journal/SCC48_Appendix-ES1.

***Appendix ES1.** Raw data for each African country used in analyses including individual lists of species reported in each country.

Appendix 1. Taxonomic affiliation, conservation status, population trends and distribution of small carnivores in Africa.

Taxon[1]	English name	*IUCN Red List* categorisation[2]	Population trend	Number of countries[3]	Distribution
Family Mustelidae					
Mustela nivalis[4]	Least (Common) Weasel	LC	Stable	2	Eurasia, North America, North Africa
Mustela subpalmata (*M. nivalis subpalmata*)	Egyptian Weasel	LC	Stable	1	Africa
Mustela putorius[4]	Western (European) Polecat (Ferret?)	LC	Decreasing	2	Europe, North Africa
Ictonyx libycus[5] (*Poecilictis libyca*)	Libyan (Libyan Striped, Saharan Striped, North African Striped) Weasel (Saharan Striped Polecat)	LC	Unknown	15	Africa
Ictonyx striatus	Zorilla (Striped Polecat, African Polecat)	LC	Stable	39	Africa
Poecilogale albinucha	African Striped (Striped, African, White-naped, Snake) Weasel	LC	Unknown	17	Africa
Aonyx capensis	African (Cape) Clawless Otter	LC	Stable	36	Africa
Aonyx congicus (*A. capensis congicus*)	Congo (Cameroon, Small-toothed) Clawless (Swamp) Otter	LC	Unknown	9	Africa
Lutra lutra	Eurasian (Common) Otter	NT (A2cd)	Decreasing	3	Eurasia, North Africa
Lutra maculicollis (*Hydrictis maculicollis)*	Spotted-necked (Spot-necked, Speckle-throated) Otter	LC	Decreasing	34	Africa
Mellivora capensis	Honey Badger (Ratel)	LC	Decreasing	44	Africa, Arabia, South Asia

Taxon[1]	English name	*IUCN Red List* categorisation[2]	Population trend	Number of countries[3]	Distribution
Family Nandiniidae					
Nandinia binotata	African (Two-spotted) Palm (Tree) Civet	LC	Unknown	28	Africa
Family Viverridae					
Genetta abyssinica	Abyssinian (Ethiopian) Genet	LC	Unknown	5	Africa
Genetta angolensis	Angolan (Miombo) Genet	LC	Unknown	6	Africa
Genetta bourloni	Bourlon's Genet	NT (A2cd)	Decreasing	4	Africa
Genetta cristata	Crested (Crested Servaline) Genet	VU (A2cd)	Decreasing	4	Africa
Genetta genetta[6]	Common (Small-spotted) Genet	LC	Stable	37	Africa, South-west Europe, Arabia
Genetta johnstoni	Johnston's Genet	VU (A2cd)	Decreasing	6	Africa
Genetta maculata	Rusty-spotted (Blotched, Central African Large-spotted, Large-spotted) Genet	LC	Unknown	31	Africa
Genetta pardina	Pardine (West African Large-spotted) Genet	LC	Unknown	11	Africa
Genetta piscivora	Aquatic Genet	DD	Unknown	1	Africa
Genetta poensis	King Genet	DD	Unknown	5	Africa
Genetta servalina	Servaline Genet	LC	Unknown	11	Africa
Genetta thierryi	Hausa (Haussa) Genet	LC	Unknown	13	Africa
Genetta tigrina	Cape (South African Large-spotted) Genet	LC	Unknown	2	Africa
Genetta victoriae	Giant (Giant Forest) Genet	LC	Unknown	3	Africa
Poiana leightoni	Leighton's (West African) Oyan (Leighton's Linsang, West African Linsang)	DD	Decreasing	2	Africa
Poiana richardsonii	Central African Oyan (African, Central African Linsang)	LC	Unknown	6	Africa
Civettictis civetta	African Civet	LC	Unknown	37	Africa
Family Herpestidae					
Atilax paludinosus	Marsh (Water) Mongoose	LC	Decreasing	37	Africa
Herpestes naso (*Xenogale naso*)	Long-nosed (Long-snouted) Mongoose	LC	Decreasing	10	Africa
Herpestes flavescens (*Galerella flavescens*)	Kaokoveld Slender (Angolan Slender, Black, Larger Red) Mongoose	LC	Stable	2	Africa
Herpestes ichneumon	Egyptian (Large Grey) Mongoose (Ichneumon)	LC	Stable	44	Africa, South-west Europe, Middle East
Herpestes ochraceus (*Galerella ochracea*)	Somali (Somalian) Slender Mongoose	LC	Unknown	3	Africa
Herpestes pulverulentus (*Galerella pulverulenta*)	Cape (Small) Grey Mongoose	LC	Stable	3	Africa
Herpestes sanguineus (*Galerella sanguinea*)	Common Slender (Slender) Mongoose	LC	Stable	39	Africa
Bdeogale crassicauda	Bushy-tailed Mongoose	LC	Unknown	7	Africa
Bdeogale jacksoni	Jackson's Mongoose	NT (A2cd)	Decreasing	3	Africa
Bdeogale nigripes	Black-footed (Black-legged) Mongoose	LC	Decreasing	6	Africa
Bdeogale omnivora (*B. crassicauda omnivora*)	Sokoke Dog (Sokoke Bushy-tailed) Mongoose	VU (A2c)	Decreasing	2	Africa
Rhynchogale melleri	Meller's Mongoose	LC	Unknown	8	Africa
Cynictis penicillata	Yellow Mongoose	LC	Stable	6	Africa
Paracynictis selousi	Selous's Mongoose	LC	Unknown	8	Africa
Ichneumia albicauda	White-tailed Mongoose	LC	Stable	33	Africa, Arabia

Taxon[1]	English name	*IUCN Red List* categorisation[2]	Population trend	Number of countries[3]	Distribution
Suricata suricatta	Meerkat (Suricate, Slender-tailed Meerkat, Grey Meerkat)	LC	Unknown	4	Africa
Mungos gambianus	Gambian Mongoose	LC	Stable	10	Africa
Mungos mungo	Banded Mongoose	LC	Stable	33	Africa
Liberiictis kuhni	Liberian Mongoose	VU (A2cd)	Decreasing	3	Africa
Dologale dybowskii	Pousargues's (Savannah) Mongoose	DD	Unknown	4	Africa
Helogale hirtula	Somali (Ethiopian, Desert) Dwarf Mongoose	LC	Stable	3	Africa
Helogale parvula	Common Dwarf (Dwarf) Mongoose	LC	Stable	15	Africa
Crossarchus alexandri	Alexander's Cusimanse	LC	Decreasing	4	Africa
Crossarchus ansorgei	Ansorge's (Angolan) Cusimanse (Angolan Mongoose)	DD	Unknown	2	Africa
Crossarchus obscurus	Common (Long-nosed) Cusimanse	LC	Unknown	5	Africa
Crossarchus platycephalus (*C. obscurus platycephalus*)	Cameroon (Flat-headed) Cusimanse	LC	Unknown	7	Africa

[1]Genus and species limits and spellings follow IUCN (2013), itself based on Wozencraft (2005), selected to be a readily available, widely used, source. Some of the more widely-used alternative taxonomic treatments and English names are given, but listings are far from comprehensive. Notably, genet taxonomy has been particularly unstable recently.

[2]DD = Data Deficient, LC = Least Concern, NT = Near Threatened, VU = Vulnerable; A2 = Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased or may not be understood or may not be reversible, c = assessment for category 'A2' based on a decline in area of occupancy, extent of occurrence and/or habitat quality, d = assessment for category 'A2' based on actual or potential levels of exploitation (IUCN 2012).

[3]Refers to the number of mainland African countries in which each species is here taken to occur, based on Bronner *et al.* (2003), Saleh & Basuony (2005), Wozencraft (2005), Dinets (2011), Ahmim (2013), N. Avenant (verbally 2013), Bahaa-el-din *et al.* (2013), IUCN (2013), Kingdon *et al*. (2013), A. Monadjem (verbally 2013) and Pacheco *et al.* (2013). To some extent these sources provide generalised distributions; they are not restricted to verifiable records. So the pattern analyses undertaken here are based upon the plausible inferred distribution of each species, rather than specific validated records of each species in each country.

[4]The origins of *Mustela nivalis* and animals identified as *M. putorius* in North Africa remain unresolved (see text).

[5]*Ictonyx* is a masculine genus so this species's name is thus correctly *I. libycus*, not *I. libyca*.

[6]South African Small-spotted Genet is sometimes given species rank (see text).

Appendix 2. Endemic African small carnivores present on African islands[1].

Island name	Country	Taxon[2]	English name[2]	Remark(s)	References
Bioko	Equatorial Guinea	*Lutra maculicollis*	Spotted-necked Otter	Former resident; now extirpated; controversial[3]	Harrington *et al.* (2002), D'Inzillo Carranza & Rowe-Rowe (2013)
		Nandinia binotata	African Palm Civet	Possibly present; historically rare	Harrington *et al.* (2002), Van Rompaey & Ray (2013)
		Genetta maculata	Rusty-spotted Genet	Possibly present	Harrington *et al.* (2002), Angelici & Gaubert (2013)
		Genetta poensis	King Genet	Possibly present	Harrington *et al.* (2002), Gaubert (2003, 2013)
		Poiana richardsonii	Central African Oyan	Present	Harrington *et al.* (2002), Van Rompaey & Colyn (2013d)
Sao Tome Island[4]	Sao Tome and Principe	*Civettictis civetta*	African Civet	Purportedly introduced	Dutton (1994)
Pemba	Tanzania	*Atilax paludinosus*	Marsh Mongoose	Absent from Unguja	Pakenham (1984)
Unguja (Zanzibar)	Tanzania	*Nandinia binotata*	African Palm Civet	Present	Perkin (2004, 2005)
		Genetta servalina archeri	Servaline Genet	Present	Van Rompaey & Colyn (1998), Goldman & Winther-Hansen (2003)
		Civettictis civetta	African Civet	Present	Pakenham (1984), Stuart & Stuart (1998)
		Herpestes sanguineus rufescens	Common Slender Mongoose	Present	Pakenham (1984), Stuart & Stuart (1998), Goldman & Winther-Hansen (2003)

Island name	Country	Taxon[2]	English name[2]	Remark(s)	References
		Bdeogale crassicauda tenuis	Bushy-tailed Mongoose	Present	Pakenham (1984), Stuart & Stuart (1998), Goldman & Winther-Hansen (2003)
		Mungos mungo	Banded Mongoose	Purportedly introduced; no recent records	Pakenham (1984), Stuart & Stuart (1998), Goldman & Winther-Hansen (2003)

[1]The Macaronesian islands (the Azores, Madeira, Savage, Canary and Cape Verde archipelagos) contain no native species of small carnivore nor any introduced African endemics, although Least Weasel *Mustela nivalis* and Western Polecat *M. putorius* and/or Domestic Ferret *M. furo* have been introduced; past reports of Common Slender Mongoose *Herpestes sanguineus* on the Cape Verde archipelago are in error (Masseti 2010, Hazevoet & Masseti 2011).

[2]Alternative taxonomic treatments and names are given in Appendix 1.

[3]Extensively treated in the past as a subspecies of *Aonyx congicus*, *A. c. poensis*; now considered synonymous with *Lutra maculicollis* (d'Inzillo Carranza & Rowe-Rowe 2013).

[4]Also supports *Mustela nivalis*, purportedly introduced (Dutton 1994, Sheffield & King 1994).