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Cover photo: Tibetan Antelope *Pantholops hodgsonii* in Ladakh, India. © K. Ahmad

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From IUCN and Antelope Specialist Group

IUCN Red List
The reassessment of all antelopes for the Global Mammal Assessment is almost complete. A few species are still working their way through the IUCN approval system and a full report will be published in *Gnusletter* once all species and subspecies assessments have been formally approved and published by IUCN.

Jens-Ove Heckel (pictured below) is a long-established member and for many years led the

North-east Africa sub-group of ASG. For the last five years he also served as Chair of the European Association of Zoos and Aquaria's Antelope and Giraffe Taxon Advisory Group (AGTAG). He has decided to step down from these two posts to concentrate on his (many) other roles – Director and Head Veterinarian at Zoo Landau in Germany, his recent appointment as Chair of the Zoologische Gesellschaft für Arten- und Populationsschutz (ZGAP; the Zoological Society for the Conservation of Species and Populations), Membership of NABU-Germany's working group on Africa, and Lecturer in Conservation Biology at the University in Landau. J-O.H. has always been very supportive of ASG and we would like to express our gratitude for his many years work on antelope conservation, both in- and ex-situ, wish him all the best is his new roles, and look forward to many more years of collaboration in the future.

Professor Colin Groves
Just as this edition of Gnusletter was being finalized, the sad news arrived that Colin Groves passed away on 30 November 2017. He was Professor Emeritus of Biological Anthropology at the Australian National University where he worked for 40 years, and was a noted taxonomist, with many contributions and publications to his credit, particularly on primates, antelopes, and other bovids. One of his last articles is published in this issue. An obituary will appear in the next issue of *Gnusletter*.

Dr Heiner Engel
On the 5th December, Dr Heiner Engel passed away after a long illness. Heiner was the former Zoological Director at Zoo Hannover, the previous EEP coordinator for addax, a founding member of SSIG and Sahara Conservation Fund and a champion of Sahelo-Saharan wildlife. An obituary will appear in the next edition of *Gnusletter*.

Meetings

SSIG
The 17th annual meeting of the Sahelo-Saharan Interest Group (SSIG) took place in St Louis, Senegal, on 4-6 May 2017. Two days of talks covered all aspects of biodiversity in this vast region and included several that concern antelopes, including: conservation work in Guembeul, Ferlo and Boundou Reserves (Senegal); translocation of Dorcas Gazelle *Gazella dorcas* to Gadabedji Reserve (Niger), an update on the Scimitar-horned Oryx *Oryx dammah* reintroduction in Chad; conservation of Western Derby Eland *Tragelaphus derbianus derbianus*; reintroduction of *Gazella cuvieri* to Serj NP (Tunisia). A field trip to Guembeul Reserve, a captive breeding and acclimatization centre for desert antelopes took place on 6 May during which Scimitar-horned Oryx, Dorcas Gazelle and Dama Gazelle were seen. In the days before, the Science and Conservation Committee

held a one-day meeting in Dakar, and the ASG Co-Chairs attended a meeting with the DPN (government agency) and Czech University of Life Sciences to discuss progress on conservation of the Critically Endangered Western Derby Eland.

Saiga Captive Breeding Workshop

A two-day workshop was held at the Institute of Ecology and Evolution of the Russian Academy of Sciences in Moscow, Russia 28-29 August 2017 to discuss captive breeding of Saiga Antelope *Saiga tatarica*. A total of 30 participants attended, representing each saiga range state and international experts.

The primary objectives of the workshop were to determine how captive breeding can contribute to saiga conservation and how to improve and coordinate existing captive breeding programs. A series of presentations summarized the current status of existing captive breeding programs, husbandry and lessons learned. Range state groups then developed national priorities for captive breeding and reintroduction (where appropriate). A full workshop report is in preparation.

Somaliland Wildlife Rehabilitation Center

The Horn of Africa has become a center for illegal wildlife trade, much of which passes through Somaliland. Cheetahs are one of the most prominent species traded illegally and a conference took place in Addis Ababa in December 2016 to discuss regional approaches to the issue, followed by a national strategy workshop in Somaliland in April 2017. The Ministry of Environment and Rural Development hosted a second workshop in Hargeisa, Somaliland, September 9-11, to develop the draft strategy, with an emphasis on an initiative to build a wildlife sanctuary for confiscated animals. The workshop was funded by the Murulle Foundation, IFAW, and GIZ and attended by senior officials and international NGOs, as well a representative of ASG. In addition to the illegal cheetah problem, antelopes are often kept as pets or for display in hotel gardens and private facilities in Somaliland (around 60 such captive individuals are currently known, comprising Speke's Gazelle, Soemmerring's Gazelle, Dorcas Gazelle, Gerenuk and Lesser Kudu). Participants discussed potential strategies and the requirements of a confiscation and rehabilitation center to house antelopes in the initial stages, and later cheetahs. A short visit was made to the site identified for the center, near Debbis. A workshop report is in preparation.

EAZA AGTAG

The EAZA Antelope and Giraffe Taxon Advisory Group (AGTAG) held a meeting during the annual EAZA conference, in Emmen, Holland, on 20th September 2017. Topics discussed included the Regional Collection Plan and support for saiga breeding centers, in view of the serious situation affecting wild populations, in particular after the recent disease outbreaks. Sander Hofman has taken over as Chair of the AGTAG and Kim Skalborg Simonsen will continue as vice-chair. ASG wishes both of them well in these important roles.

Forthcoming meetings:

- 19th Sharjah International Conservation Workshop on Arabian Biodiversity, 5-8 February 2018, Sharjah, UAE.
- CMS Central Asian Mammals Initiative midterm review workshop, 16-20 April 2018, Wilm, Germany.
- 18th annual SSIG meeting, May 2018, Paris.

Opinion

A comment on the ASG Taxonomy Policy, Appendix 1.

Colin P. Groves†, *Australian National University*

This Appendix to the ASG Taxonomy Policy reveals a good deal of misunderstanding about species and their ontology and recognition. Since the insights of Mayden (1997), it has been clear that the Evolutionary Species Concept (ESC) is not just "another species concept": it is the essence of the species, and the Biological Species Concept (BSC) and Phylogenetic Species Concept (PSC) are criteria for operationalising the ESC. The Appendix evidently misinterprets Cracraft's (1983) reference to "a parental pattern of ancestry and descent", and unfortunately does not quote the definition given in Groves & Grubb (2011), which emphasises the population nature of the PSC. The Appendix suggests that the PSC risks misinterpreting widely separated geographic samples of clines, and populations separated by anthropogenic factors: but these are potential stumbling blocks in any taxonomic arrangement. It warns that recognising species under the PSC "could prevent genetic rescue by reinforcement with individuals from outside that 'subpopulation/species', a potentially harmful consequence"; this surely applies well below the species level, however the latter is defined, because genetic supplementation is fraught with perils, regardless of taxonomy (Miller et al. 2006). Finally, it notes that "The principle of diagnosability is open-ended, some improvements in the refinement of analytical processes will inevitably lead to increased resolution of 'diagnosability'. Applying the principle of diagnosability inevitably leads to an increase in the number of 'species'…" This is not a fault. It is in fact a characteristic of science: as our knowledge and understanding increase, our hypotheses must be modified.

History of species concepts

The BSC is best summed up in the definition offered by Mayr (1963): "Species are groups of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups". An alternative, the Evolutionary Species Concept (ESC) defines a species as "a lineage (an ancestral-descendant sequence of populations) evolving separately from others and with its own unitary evolutionary role and tendencies" (Simpson, 1961). Simpson's definition was generally overlooked, and most taxonomists followed Mayr's definition despite increasing unease with its drawbacks. In particular, nobody was quite clear about what was meant by "potentially interbreeding", and the fact that apparently closely related populations are commonly allopatric (occurring in separate, non-overlapping geographic areas) rendered the application of the Biological Species Concept entirely arbitrary in most cases. It was this tension between theory and practice that led to the proposal of over a score of "species concepts", most notably the Phylogenetic Species Concept (PSC) in which a species is "the smallest diagnosable cluster of individual organisms within which there is a parental pattern of ancestry and descent" (Cracraft 1983). Meanwhile, the "molecular revolution" brought to light cases of interbreeding between what had always been regarded as "good" species. Indeed, among some Primates, it turned out that interbreeding had been rife during their evolution, such that some species, even whole genera, are of hybrid origin (Roos et al. 2011). One can also detect such cases among African antelopes (Groves 2014).

All the various species concepts were discussed by Mayden (1997), who distinguished between theoretical concepts and operational definitions, and argued that the primary concept is the ESC, which "is the only available concept with the capacity to accommodate all known types of biologically equivalent diversity". A similar sentiment was expressed by de Queiroz (2007 and elsewhere) in his General Lineage Concept (GLC): "Every lineage is a species". This recalls the Individuality Thesis of Ghiselin (1974), which views species as individuals, each with its own internal economy, sustaining itself out of its own resources. The ESC/GLC and the Individuality Thesis remind us that, while taxonomy as such is

a human artefact, species themselves have a real existence.

The ESC/GLC clarifies what species are, but we still need to be able to recognise them in practice. Mayden (1997) recommended that the evolutionary species be operationalised by the PSC: "The set of operations necessary to discover diversity associated with species are clearly outlined", and he rejected the BSC: "the ability to interbreed is viewed as a shared-primitive attribute and is not of consequence in the recognition of species as taxa". De Queiroz (2007) argued that all "species concepts" other than the ESC/GLC are characteristics that may arise at different times after the origination of an evolutionary species: failure to interbreed with other species, for example, may or may not evolve during a species' existence (see also Rabosky & Matute 2013).

Groves & Grubb (2011) used the PSC to propose new taxonomic arrangements of Perissodactyla and Artiodactyla, and defined species as: "A species is the smallest population or aggregation of populations which has fixed heritable differences from other such populations or aggregations". This definition has three strands:
1) Species are populations (or aggregations of populations);
2) The differences between species, as far as the evidence goes, are heritable (not due to phenotypic plasticity);
3) These differences are fixed (in the genetic sense, meaning consistent, 100%, characterising all members given age/sex variation).
The Groves & Grubb (2011) revisions are testable, as scientific propositions should be, whereas taxonomy under the BSC is not testable. It is unfortunate that no such testing has been forthcoming: instead, there has been mainly hostility to the very idea of the PSC. Most of these criticisms have, I am sorry to say, been spurious: splitting ("taxonomic inflation") is somehow inimical to conservation, as Zachos et al. (2013) maintained.

Bradley & Baker (2001) proposed that the PSC be modified by recognising as species only those candidate populations differing from their relatives by a certain genetic distance. Tobias et al. (2010) suggested a cumbersome scheme of counting up differences in morphology, DNA, vocalisation etc., setting a threshold above which the species should be recognised. Both of these proposals raise criteria that seem arbitrary and subjective. Hausdorf (2011) proposed a Differential Fitness Species Concept, under which species are defined as "groups of individuals that are reciprocally characterised by features that would have negative fitness effects in other groups and that cannot be regularly exchanged between groups upon contact"; this is a reiteration of what Mayr (1963) had argued was involved in the evolution of reproductive isolation, and is not at all useful as an operational criterion. Interestingly, Zachos (2016), since his numerous writings against the PSC, has undergone a rethink and has written a useful book detailing the history of the species concept and embracing the Individuality Thesis.

Case studies

It may be helpful to bring these principles home with a couple of case studies of African antelopes. 1) St Leger (1934) described two new species of duiker, *Cephalophus fosteri* from Mt. Elgon and *C. hooki* from Mt. Kenya, stating that "they appear to be closely related to *nigrifrons* of the Congo and *rubidus* of Mt. Rwenzori". Subsequent authors, including St Leger herself, downgraded them to subspecies of *C. nigrifrons*, as *C. n. fosteri* and *C. n. hooki* respectively, although Grubb & Groves (2001) did note that they are "very distinct… and we have considered whether to separate them as species level; but this would risk leaving the rest of *C. nigrifrons* paraphyletic". Grubb & Groves (201) also described a new subspecies, *C. n. hypoxanthus*, from the Itombwe Mountains. Later, Groves & Grubb (2011) restored both *fosteri* and *hooki* as full species, admitting also *hypoxanthus* as a species. It is unclear whether *hypoxanthus* is in genetic contact with *C. nigrifrons*, but *fosteri* and *hooki* are certainly not. The BSC/DFSC offers no guidance here: would they interbreed with *C. nigrifrons* if their ranges were to meet? - nothing but speculation is available. On the other hand, the PSC gives a clear imperative: they constitute populations separate from *C. nigrifrons* and from each other, and they differ in multiple morphological characters (no DNA studies appear

to have been undertaken on them as yet). Quite incidentally, it is clearly important for conservation to note that the highland forests of Mt. Elgon and of Mt. Kenya and the Aberdares (where *C. hooki* also occurs) are home to endemic species of duiker.

2) The genus *Alcelaphus* (hartebeest) is often regarded as being monotypic, despite there being eight very distinctive "subspecies". Capellini (2007) showed that some of the species are "heavily armed", with heavy skulls and horns in the male, whereas others are "lightly armed", and she related this to breeding season length and fighting ability. An mtDNA study by Flagstad et al. (2001) showed three major geographic clades – southern, eastern and western – with some intermixture among three "subspecies" (*swaynei*, *cokii* and *lelwel*) within the East African clade. The intermixture between *lelwel* and *cokii* was examined in more detail by Ouma et al. (2011), who showed morphological intermediacy between them in several regions, which the microsatellite distribution more or less tracked, although the mitochondrial D-loop of *cokii* was more widespread, suggesting that *lelwel* had, in the past, "invaded" *cokii* populations, leading to nuclear swamping.

Morphologically, the differences between the so-called "subspecies" of hartebeest are conspicuous and consistent, and Groves & Grubb (2011) suggested restoring them to the species status under which they were originally described. Even the barrier between *Alcelaphus lelwel* and *A. cokii*, despite the occurrence of hybridisation, is narrow, and each occupies a wide range within which it is homogeneous (and the same seems to be true of their interfaces with *A. swaynei*). No hybrids are known from elsewhere, though of course they may prove to occur. Hybridisation, at any rate, does not disturb the separate evolutionary lineage status of any of the eight species. I may note that Heckel et al. (2008) reported that one of the "subspecies", *A. b. tora*, could not be found despite searching, and is possibly extinct. One wonders whether, if it had been recognised as a distinct species (*Alcelaphus tora*) all along, rather than having been arbitrarily sunk into a catchall *Alcelaphus buselaphus*, it might have been more conspicuous for conservation purposes (see also Gippoliti et al. 2017).

Species concepts and conservation

One of the claims made about the PSC is that the consequent "taxonomic inflation" is somehow harmful to conservation (Zachos et al. 2013b); this was refuted in detail by Gippoliti et al. (2017) who argued that on the contrary, it is taxonomic inertia which is harmful. Such claims had in fact already been examined some years earlier (Hazevoet, 1996; Morrison et al. 2009): as analysed by these authors, species splitting, PSC-style, always helped protection. In response to Zachos et al. (2013b), Gutiérrez & Helgen (2013) noted again that simplification (taxonomic inertia) is harmful to conservation: "modern integrative approaches have shown that this tactic has hidden an incommensurable number of distinctive species from conservation efforts… Thereby increasing the risk of extinctions". "A better understanding of the natural world will always positively impact conservation policy" (Raposo et al. 2017).

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Original Articles

Carl Theodor Eriksson, an overlooked early collector of endemic Zambesi Basin region antelopes

Henry Pihlström
Department of Biosciences, Physiology and Neuroscience, P.O. Box 65 (Viikinkaari 1), 00014 University of Helsinki, Finland.

Summary
In the early years of the twentieth century, the Finnish prospector and colonial official, Carl Theodor Eriksson (1874-1940), traveled widely in parts of what were then north-eastern Rhodesia and the Katanga region in the Belgian Congo. During this time, Eriksson collected several antelope specimens for the institution that is today known as the Finnish Museum of Natural History in Helsinki, Finland. Among these specimens were, unbeknownst to Eriksson and his contemporaries, representatives of endemic Zambezi Basin taxa that would not be described scientifically until many decades later. They include a specimen of the Lake Bangweulu tsessebe Damaliscus lunatus superstes, and two specimens of the currently Critically Endangered Upemba lechwe Kobus leche anselli; Eriksson's Upemba lechwe may, in fact, be the earliest scientifically collected specimens of their kind. In order to place the significance of Eriksson's specimens in a wider context, a short review of lechwe taxonomy is presented, together with remarks about the implications for this taxonomy on research and conservation of antelopes in general. It is suggested that antelope populations which are distinct but taxonomically "invisible" are at greater risk of becoming overlooked not only in museum collections but also in conservation efforts.

In recent years, it has become apparent that our knowledge of the taxonomic diversity within the family Bovidae is still far from complete. Species that are entirely new for science have been discovered during the last few decades (Dung *et al*. 1993, Colyn *et al*. 2010). Other new taxa have been recognized as a consequence of applying novel species concepts (e.g. Grubb and Groves 2001). The most notable individual contribution on this subject has probably been Colin Groves and Peter Grubb's 2011 book *Ungulate Taxonomy*. In this volume, the authors recognize approximately twice as many ungulate (including bovid) species as is customary in "traditional" classifications.

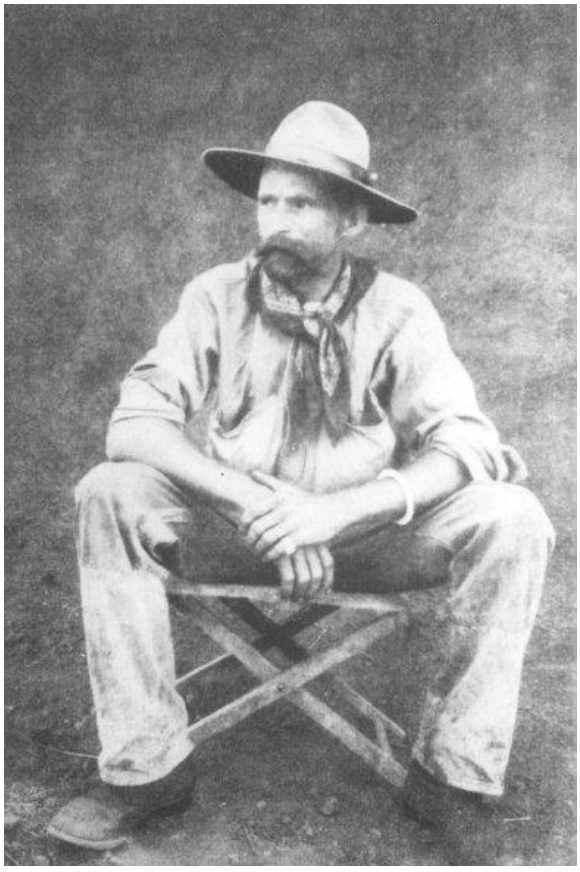
The response to such dramatically new proposals has been mixed (for a supportive view, see José Castelló's 2016 book *Bovids of the World*), and here is not the place to review this discussion. However, the combined effect of publications such as Groves and Grubb (2011) on the one hand, and the development of new, sophisticated research methods (especially in molecular biology) on the other hand, has been an increased appreciation of the potential importance of old mammalogical collections housed in natural history museums around the world. Such collections may include representatives of populations that have become rare or even extinct in the wild. Thus, old museum specimens can provide unique insights into the phylogeny and phylogeography of taxa that would otherwise be difficult or impossible to study (e.g. Pitra *et al*. 2006, Bärmann *et al*. 2013).

Partially inspired by these new developments in the field of bovid taxonomy, the present author undertook in 2016 and 2017 a systematic survey of the non-native mammal specimen collection in the Finnish Museum of Natural History (FMNH) in Helsinki, Finland. This collection includes a small number of wild-collected bovids, mainly from Africa and Eurasia. Of particular interest turned out to be specimens collected by the Finnish prospector, adventurer and big-game hunter Carl Theodor Eriksson (1874-1940) (Figure 1) in the Zambezi Basin region in southern Africa at the beginning of the twentieth century. C.T. Eriksson (whose surname is sometimes misspelled "Ericson" or "Erickson" in secondary sources) was born into a Swedish-speaking working-class family in Helsinki, the capital of what at the time was an autonomous

part of the Russian Empire, the Grand Duchy of Finland. Eriksson, who did not fancy his career prospects in his native country, moved to South Africa in 1895. After having spent a few years in the Cape of Good Hope, Eriksson entered into the service of a British mining company, and travelled northwards to north-eastern Rhodesia (subsequently Northern Rhodesia, and today the Republic of Zambia).

During the first decade of the 20th century, he traveled in various parts of north-eastern Rhodesia and the Belgian Congo (present-day Democratic Republic of the Congo), mainly prospecting for copper. Eriksson brought with him a camera, and, despite the often-challenging conditions in the field, he managed to produce a fairly extensive photographic record of his activities. Eriksson later wrote an autobiography of his African years in his native Swedish (Eriksson 1932); a Finnish translation was also published. Thanks to all this photographic and written material, C.T. Eriksson's African travels are, for the most part, well documented; see Särkkä (2015) for an overview.

Figure 1. Carl Theodor Eriksson, photographed in 1901. Original photo is in the Institute of Migration, Turku, Finland.



In addition to his official administrative duties, Eriksson collected zoological specimens for his native country. Eriksson was not a professional naturalist, but he
was a skilled hunter and a keen observer of wild animals. He entered an agreement with Finnish naturalists to collect a representative sample of African animals (mostly large mammals) to be sent to the fledgling natural history museum in Helsinki. Eriksson's collecting trips took place mainly in September–October 1906, in north-eastern Rhodesia and in the Katanga region of the Belgian Congo.

He collected specimens in an area approximately bordered by the Lualaba River in the west, by the upper reaches of the Lufira River (it is unclear exactly how far north towards the Upemba Lakes Eriksson travelled) and Lake Mweru in the north, by the Luapula River and Lake Bangweulu in the east, and by the Broken Hill (present-day Kabwe) region in the south. All in all, the zoological material that C.T. Eriksson sent to Finland included more than 30 individual mammal specimens, mostly antelopes (Table 1). Among these were a few specimens that, unbeknownst to Eriksson and his contemporaries, represented taxa that would not be scientifically described until nearly a century later. Among the historically notable antelope specimens that Eriksson collected is a male tsessebe that he shot south of Lake Bangweulu, near the Luapula River in October 1906. Eriksson noted that the animal, which he photographed and illustrated in his memoirs (Eriksson 1932:310), possessed unusually large and robust horns for a tsessebe. The skin was mounted and sent to the natural history museum in Helsinki, where it remains today (Figure 2). Neither in his handwritten field notes nor in his memoirs did Eriksson consider the possibility that the Lake Bangweulu tsessebe might be taxonomically distinct from tsessebe *Damaliscus lunatus* in other parts of Africa. However, the Lake Bangweulu tsessebe are geographically isolated from other *Damaliscus* populations, and available evidence suggests that this isolation is of relatively ancient origin (Cotterill 2003a,b). The Lake Bangweulu tsessebe are also morphologically distinct from other tsessebe, most notably regarding the size and shape of their horns (Cotterill 2003b, Castelló 2016). Due to its distinctiveness, Cotterill (2003b) described the Lake Bangweulu tsessebe as a

separate species, *Damaliscus superstes*. This species-level distinction was supported by Groves and Grubb (2011) and Castelló (2016). The IUCN Red List also recognizes the Lake Bangweulu tsessebe as taxonomically distinct, although only subspecifically, as *Damaliscus lunatus superstes* (IUCN SSC Antelope Specialist Group 2017a).

Of even greater historical interest are the lechwe that Eriksson collected. According to his field notes, two male lechwe specimens were shot in September 1906 in Katanga, in the vicinity of the Lufira River, which at the time was not yet dammed (Magis 1962). Eriksson collected only the horns of one of these specimens, and the whole skull of the other (Figures 3a and b), and also the skins of both individuals. In his field notes, he identified these animals as "red lechwe", and provided a few additional notes about their habits and distribution. He wrote that red lechwe were "common" (although localized) in both Katanga and in the vicinity of Lakes Mweru and Bangweulu, but that they were "never" found by the Lualaba River. Eriksson also noted that in Katanga, the horns of red lechwe were "always" smaller than the horns of red lechwe further south, in the Kafue region (which Eriksson had visited on earlier occasions).

Figure 2. Bangweulu tsessebe *Damaliscus lunatus superstes*, specimen UN 137, FMNH. (The sloth does not belong to C.T. Eriksson's collection of African animals.) Photo: Henry Pihlström.

On October 9 1906, Eriksson shot a male black lechwe south of Lake Bangweulu; he later published a photograph of this specimen in his memoirs (Eriksson 1932:310). So impressed was Eriksson by his quarry that he wrote in his book that red lechwe are "banal" by comparison (Eriksson 1932:313). This disparaging comment is the only mention of red lechwe in Eriksson's published memoirs. He collected both the black lechwe's skull and skin (Figure 4). Embedded in the skin, Eriksson found several botfly larvae which he also collected. Later, in Helsinki, these larvae were found to represent a species of botfly new to science, named *Strobiloestrus erikssoni* after its discoverer (Poppius 1907).

C.T. Eriksson appears to have been either uninterested in or, more likely, unware of the contemporary complexities of lechwe taxonomy. The original "red lechwe" *Kobus leche* or southern lechwe was described in the mid-19th century (Gray 1850). (Another lechwe species, the Nile lechwe *Kobus megaceros* was described

shortly thereafter (Fitzinger 1855), but this species does not live in the Zambezi Basin region and is therefore of no concern for the present discussion. From here on in this text, "lechwe" refers exclusively to members of the southern African *Kobus leche* species complex.) A few decades later, the superficially quite distinct black lechwe was described as a separate species by Lydekker (1899). The majority of later authors have, however, preferred to consider it merely a separate subspecies (*Kobus leche smithemani*) of the red lechwe. Rothschild described the so-called Roberts' lechwe as a new species shortly thereafter (Rothschild 1907). In this case, too, subsequent authors have generally accepted this form as a valid taxon, but only at the subspecies level (*Kobus leche robertsi*). Later still, the Kafue population of red lechwe *Kobus leche kafuensis* was recognized as subspecifically distinct by Haltenorth (1963). Most recently, Cotterill (2005, 2006) described the Upemba lechwe from the Katanga region as a separate species-level taxon, *Kobus anselli* (see below).

Before the 21st century, there had been only a few serious attempts to revise lechwe taxonomy. Barclay (1933) thought, on the basis of a rather cursory examination of lechwe pelage coloration, that only the black lechwe was taxonomically distinct, and that no other subspecies should be recognized. Howard and Sidorovicz (1976) compared skull sizes in different lechwe populations, and found that, while the black lechwe was on average smaller than the red lechwe and thus, in their view, probably a valid taxon, the "common" red lechwe and the Kafue red lechwe did not significantly differ from each other regarding skull size. Therefore, Howard and Sidorovicz (1976) also argued against recognizing different subspecies of red lechwe. However, Ansell and Banfield (1979) later showed that these analyses were flawed. The supposed "common" red lechwe sample studied by Howard and Sidorovicz (1976) actually consisted of erroneously labeled Kafue lechwe specimens, so Howard and Sidorovicz had, unwittingly, performed a within-population morphological comparison (which, unsurprisingly, did not find any significant size differences).

The phylogenetic relationships between the various lechwe taxa are still mostly unresolved. There have been few molecular studies on lechwe, and most of these have included only some of the purported species/subspecies. Both De Meneghi *et al*. (1995) and Birungi and Arctander (2001) included representatives of just three taxa, namely, *Kobus leche leche*, *K. l. kafuensis*, and *K. l. smithemani*. Specimens of *Kobus leche robertsoni*, which by the time was already extinct, were not available for genetic study. Both De Meneghi *et al*. (1995) and Birungi and Arctander (2001) concluded that the three compared taxa are distinct, but only subspecifically. Birungi and Arctander (2001), however, qualified their conclusion by noting that additional molecular data are needed to fully resolve this question.

Ever since the 1950s, some zoologists, notably W. F. H. Ansell, had suggested that lechwe taxonomic diversity was underestimated and in need of a critical revision (e.g. Ansell 1958, Grimwood *et al*. 1958). These suggestions were followed up by Cotterill (2000) in a major departure from the by then fairly established lechwe classification. On morphological grounds, Cotterill (2000) suggested that the black, Roberts', and Kafue lechwe should all be elevated to full species status, alongside the "common" red lechwe. Later, following a study of the hitherto poorly known Upemba lechwe, Cotterill (2005) described it too as a separate species, bringing the number of extant and recently extinct species in the *Kobus leche* species complex to five. Still later, Cotterill (2006) expanded his dataset to also include molecular characters. Cotterill's molecular phylogenetic analysis, which suggested that the divergence dates of the five lechwe taxa are relatively recent, was unfortunately not able to fully resolve lechwe phylogeny; it did, however, suggest that the Upemba lechwe lineage was among the first (perhaps even the first) to diverge from other lechwe populations (Cotterill 2006). Morphologically, the Upemba lechwe is notable for being, on average, smaller than other lechwe taxa, especially in its skull and horn dimensions (Cotterill 2005, Castelló 2016; cf. Eriksson's field notes, quoted above).

As the holotype for the Upemba lechwe Cotterill (2005) chose a specimen that was collected in 1926 by J.T. Zimmer. This represented, at the time of Cotterill's description, the earliest known collected material of the Upemba lechwe. However, the two "red" lechwe specimens

collected by C.T. Eriksson in Katanga in 1906 pre-date Zimmer's specimen by two decades. That these FMNH specimens indeed represent Upemba lechwe is beyond reasonable doubt, not only because of their locality data but also their skull and horn dimensions, which agree with the data presented by Cotterill (2005).

Figure 3. Upemba lechwe (*Kobus leche anselli*). 3a (left), specimen UN 288, FMNH. Eriksson's original handwriting is visible on the parietal bones. Figure 3b (right), specimen UN 3000, FMNH. Photos: Henry Pihlström.

At the time of Eriksson's collecting trip, all the various lechwe taxa appear to have been plentiful in the Zambezi Basin region. Since then, however, many populations have drastically decreased and their distributions have become more fragmented. Roberts' lechwe became wholly extinct, apparently unnoticed by contemporary observers, by the mid-20th century (Cotterill 2006). The black lechwe has disappeared from large parts of its former range (Thirgood *et al*. 1994, Kamweneshe 2000, Siamudaala *et al*. 2012). The Kafue lechwe, while still fairly abundant, has also been decreasing (Chansa and Kampamba 2010). The most seriously threatened of the surviving lechwe taxa is the most recently described, the Upemba lechwe, which is classified as Critically Endangered (IUCN SSC Antelope Specialist Group 2017b). Its current population size is estimated to be fewer than 1,000 individuals (Cotterill 2005). It seems likely that an important reason why the plight of the Upemba lechwe has not been properly recognized until very recently is because its distinctiveness from other lechwe has remained unknown to science for so long; such taxonomic "invisibility", in turn, may seriously impede conservation efforts (Cotterill 2005, 2006).

The current precarious status of some of the surviving lechwe taxa, and the Upemba lechwe in particular, makes preserved museum specimens particularly valuable, and in some cases effectively irreplaceable. Sadly, not even deposition in a museum collection has always sufficed to prevent specimens from being lost to science. C.T. Eriksson, as noted, collected both skull and skin material of the Upemba lechwe. However, during the early 20th century (particularly during the Second World War) some parts of the FMNH collections, unfortunately including Eriksson's material, were kept in storage facilities that were not optimal for the preservation of specimens. Eventually, the condition of the flat skins of the two Upemba lechwe specimens had deteriorated to such an extent that in 1991 a decision was made to destroy them. Eriksson's black lechwe skin, which had remained in better condition, was fortunately spared. There is little doubt that a major contributing factor to the regrettable decision to destroy these Upemba lechwe skins was that they were, at the time, considered to merely represent "common" red lechwe. If there had been a serious suspicion in the early 1990s that Eriksson's lechwe specimens from Katanga might represent a taxonomically distinct population, this material

would surely not have been destroyed, poor condition or not. Hopefully, the present publication will stimulate other researchers and institutions to critically re-examine museum specimens of bovids that were collected before the taxonomic revisions and new taxon descriptions that have appeared in recent years. It is possible and perhaps even likely that such re-examination will expose additional, previously overlooked specimens of rare or extinct bovid taxa in the collections of the world's natural history museums.

Table 1. Antelope specimens collected by C. T. Eriksson in North-Eastern Rhodesia (NER) and Katanga (KAT) in 1906 for the Finnish Museum of Natural History. Species-level taxonomy follows the IUCN Red List.

Taxon	*N*	Collection locality/localities
Sylvicapra grimmia splendidula	1	NER ("Musambo River"[a])
Ourebia ourebi hastata	2	NER ("Chongola, near the Luapula River")
Tragelaphus oryx livingstonii	1	NER ("East of the Luapula River")
Alcelaphus lichtensteinii	2	NER ("Broken Hill"), KAT ("Kambowe")
Damaliscus lunatus superstes	1	NER ("South of Lake Bangweulu")
Hippotragus equinus	2	NER ("Broken Hill"), KAT
Hippotragus niger kirkii	4	NER, KAT ("Kambowe")
Redunca arundinum	3	NER ("South of Lake Mweru"), KAT
Kobus ellipsiprymnus defassa	2	NER ("North of Broken Hill")
Kobus vardonii	7	NER, KAT
Kobus leche anselli	2	KAT ("Lufira River")
Kobus leche smithemani	1	NER ("South of Lake Bangweulu")

[a] Exact present-day locality uncertain.

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Figure 4. Black lechwe (*Kobus leche smithemani*), specimen UN 898. Photo: Henry Pihlström.

Analysis of temporal population trend and conservation of Tibetan Antelope in Chang Chenmo Valley and Daulat Beg Oldi, Changthang, Ladakh, India

Khursheed Ahmad[1*], Riyaz Ahmad[2], Parag Nigam[3] and Jigmit Takpa[4]
[1]*Centre for Mountain Wildlife Sciences, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar 190025, Srinagar, J & K, India.*
[2] *Wildlife Trust of India, Jammu & Kashmir Chapter, Srinagar, J & K India;*
[3] *Wildlife Institute of India, Chandrabhani 248001, Dehradun, Uttarakhand*
[4] *Department of Wildlife Protection, Jammu & Kashmir Government*
** Corresponding author email: khursheed47@gmail.com*

Abstract
The Tibetan Antelope or Chiru *Pantholops hodgsonii* is a threatened antelope also listed in Appendix 1 of CITES. It is endemic to the Qinghai-Tibet Plateau which lies almost entirely in China. A small population however, migrates into the Chang Chenmo Valley (CCV) and Daulat Beg Oldi (DBO) areas in eastern Ladakh, India. We report a comparative analysis of the structure and temporal trend of this population and conservation concerns observed in both areas during preliminary surveys in 2004–2006 and more intensive studies during 2012-2014. The surveys were carried out along nine line transects in four survey blocks each in Chang Chenmo Valley and Daulat Beg Oldi. The results indicate that these areas of Ladakh hold a seasonal population of 300-350 Tibetan Antelope and contrary to earlier reports that the entire population migrates back to China during winter, we found a small population of around 15-20 individuals stayed in Chang Chenmo Valley during winter. We estimated a population of 64 Tibetan Antelope in Chang Chenmo in 2004, 55-60 in 2005 and 40-45 in 2006, we observed 75-80 Chiru in 2012, 70-80 in 2013 and 80-95 in 2014. Group size varied from 6.30 (±4.82) in 2004 to 6.34 (±5.15) in 2014 while encounter rates varied from 1.13 (±1.06) in 2004 to 1.20 (±1.18) /km in 2012-2014. In DBO 230 Tibetan Antelope were estimated in 2005 and 200-250 in 2006. We could survey only a part of the DBO area during 2012-2014 and estimated a population of 260-280. Disturbance due to livestock and the accompanying herders and dogs might have reduced to a large extent owing to strict regulations imposed by security agencies on the movement of *changpa* (nomads) of Changthang and their livestock into the area. Feral dogs and dogs accompanying the Indo-Tibetan Border Police and Army installations are still a major threat. Monitoring of socio-economic circumstances may be as important to Tibetan Antelope conservation as scientific population monitoring, surveillance and management.

Introduction
The Tibetan Antelope or Chiru *Pantholops hodgsonii* is endemic to the high plains of the Qinghai-Tibet Plateau, most of which lies in China, with a small extension in Ladakh in northern India. It is a Schedule 1 species under the Indian Wildlife Protection Act 1972 (amended 2006) and Jammu & Kashmir Wildlife Protection Act 1978 (amended 2006). It was until recently listed as Endangered on the IUCN Red List because of large scale poaching for its under fleece, *shahtoosh*, which was smuggled into Kashmir and woven into shawls. Efforts taken to stop the *shahtoosh* trade have helped the chiru to recover and the global population is reported to have doubled since the mid-1990s with present population estimated between 100,000 (Leslie and Schaller 2008) and c. 150,000 (Liu 2009). The species has recently been reassessed as Near Threatened due to the recovery of the main population in China (IUCN SSC Antelope Specialist Group 2016). The migratory nature and clumped distribution of the Tibetan Antelope complicate extrapolation and calculation of accurate population estimates, but most of the reliable sources agree that the population has been increasing (Leslie and Schaller 2008; IUCN SSC Antelope Specialist Group 2016).

Most Tibetan Antelopes occur in China but a small population migrates to two sites in extreme northern India, the Chang Chenmo Valley (CCV and Daulat Beg Oldi (DBO), both located in the Ladakh region (Fig. 1). No more than 2,500 km^2 of habitat have been estimated to lie within Indian territory. However, a large part of the Aksai Chin

region, where summer populations of Tibetan Antelope also occur, is currently under Chinese control. Some populations are sedentary, others migratory (Schaller, 1998). Information on the status, trend and conservation of the Indian population is limited. We undertook preliminary surveys in 2004-2006, followed by a more intensive study in 2012-2015 to enhance knowledge on the population size and structure of Tibetan Antelope in India, and conservation implications for ensuring long term survival of the species and its habitats.

The study was carried out in Daulat Beg Oldi (DBO) and Chang Chenmo Valley (CCV) (34.00 N-34.37N and 78.10 E-9.00E) (Fig. 2). These sites lie within the westernmost extension of the Tibetan Plateau and vary in altitude from 4450 to 5800 m asl and are located north and north-east of Pangong Tso lake and 84 km from the last habitable village of Phobrang (Namgial 2009; Shawl and Takpa 2009; Ahmad and Nigam 2015). The area falls administratively under Durbuk Block of Leh. CCV lies within Changthang Wildlife Sanctuary (>3100 km^2). DBO (consisting of Gaptain and Depsang Plains) lies in Karakoram Wildlife Sanctuary. DBO has limited human habitation and is a restricted area due to security considerations.

Tibetan Antelope in Ladakh, India. Photo K. Ahmad

Methodology

CCV and DBO were stratified into five survey blocks with nine transects in each, varying in length between 6 and 10 km, based on differences in altitude, aspect, habitat and degree of human disturbance. Line transect (Buckland *et al.* 2001) and trail monitoring (Rutledge 1982) methodology were adopted for collecting data on distribution and abundance. All transects were surveyed four times a month at 05.00-12.00 and 15.00-18.00. For every Tibetan Antelope sighting, data on population size, structure, were recorded, along with date. Duplications were deleted by comparing time, locality and group composition.

Results and Discussion

The preliminary survey conducted during July–September in 2004, 2005 and 2006 indicated that the Tibetan Antelope population in both areas remained more or less stable except for a dip in 2006 which could be attributed to the survey in 2006 been conducted during the time of the year i.e. October 2006 when outward migration of the Chiru population starts (Table 2). We estimated a population of 64 Tibetan Antelope in Chang Chenmo in 2004, 55-60 in 2005 and 40-45 in 2006, we observed 75-80 in 2012, 70-80 in 2013 and 80-95 in 2014 (Table 1). Group size varied from 6.30 (±4.82 CI) in 2004 to 6.34 (±5.15) in 2014. Encounter rates varied from 1.13 (±1.06) in 2004 to 1.20 (±1.18) Tibetan Antelope/km in 2012-2014. In DBO, 230 Chiru were estimated in

2005 and 200-250 in 2006. We could survey only a part of the DBO area during 2012-2014 and observed a population of 80 females with young and estimated 260-280 Tibetan Antelopes in DBO. During 2012-2015, 162 surveys were carried out in the nine transects and four survey blocks involving a total time effort of 1208.85 hours and distance of 918.60 km walked. The study indicated that in addition to Tibetan Antelope, Chang Chenmo Valley holds other mammals such as Wild Yak *Bos mutus*, Tibetan Argali *Ovis ammon hodgsoni*, Tibetan Wild Ass *Equus kiang*, Blue Sheep *Pseudois nayaur*, Tibetan Wolf *Canis lupus chanco* and Red fox *Vulpes vulpes*.

Out of the total of 1604 individuals of eight different species which were recorded, the maximum number of sightings and individuals recorded were of Tibetan Antelope with a mean encounter rate of 1.53/hr and 1.20/km (n = 92 group sightings and 583 individuals) (Fig. 3). The chiru sighting encounter rates/hr effort and per kilometer walk varied significantly (F=19.97 *P*= 0.000; F= 17.95 *P* = 0.000 respectively). Chiru group size usually varied from solitary animals up to 12 although two groups during the late summer comprised 23 and 19 individuals. Group size varied between seasons. The mean group size in Chang Chenmo was 6.3 (± 4.82) in 2004 and 6.34 (±5.15) in 2014 whereas in DBO the mean group size varied from 4.33-4.66 in 2005/2006 to 6.5 during 2012-2014. Only males (adult and subadult) were seen in CCV whereas in DBO females with young were encountered in all sightings. However, some males were seen in the female area of DBO for the first time. During one survey a group of 80 females with young were recorded from the Galwan Nullah, along Kugrang Nullah adjacent to DBO, confirming the reported presence of Chiru in this area.

We confirmed that the timing of inward migration of Tibetan Antelope from Tibet to CCV is in April, not May as suggested by Schaller (1997) and Wright and Kumar (1997). Contrary to previous reports of outward migration of the entire Tibetan Antelope population to the Chinese sector of the Tibetan Plateau in October (Schaller 1998; Sarkar et al. 2008; Namgail 2009) we observed that around 15-20 individuals stayed in CCV during winter. In CCV, the Tibetan Antelope was seen mostly at the Hot Spring area and occasionally at K. Hill. It has not been reported beyond K. Hill so far. During our surveys over 10 days in February 2014, in the Thratsang La, where a new location for Tibetan Antelope had been reported (Sankar et al. 2011), we did not have any direct sightings of Chiru or find any indirect evidence of its presence in the area. The resident nature of the Chiru population in CCV is supported by our studies we conducted using the control region marker (Ahmad et al. 2016), documenting for the first time the genetic variation of the Indian population of the Tibetan antelope, the extent of migration and its relationships with other populations which indicated absence of Chiru migration from India to Qinghai Tibetan Plateau (QTP) (Ahmad et al. 2016).

Table 1. Population Status of Tibetan Antelope in Chang Chenmo Valley and Daulat Beg Oldi in 2004-2014.

	Chang Chenmo Valley			Daulat Beg Oldi		
Year	No of Groups	No of TA	Pop. estimate	No of Groups	No of TA	Pop. estimate
2004	10	63	63			
2005	19	120	55-60	142	662	250
2006	05	18	40-48			246
2012	42	217	75-80			
2013	18	131	70-80	03	120	250-280
2014	32	193	80-90			

Conservation Measures

Special efforts and measures are required to ensure the survival of the Indian population of Tibetan Antelope. Disturbance due to livestock and the accompanying herders and dogs might have reduced to a large extent owing to strict regulations imposed by security agencies on the movement of *changpas* (nomads) of Changthang and their livestock into the area. However, feral dogs and dogs accompanying the Indo-Tibetan Border Police and Army installations in the area still pose a potential threat to wild animals including Tibetan Antelope. Some signs of poaching can be found, although the area is recovering from past hunting pressures. Drafting of a proper management plan for the area to conserve the Tibetan Antelope, Wild Yak and other important species of this cold desert ecosystem is needed urgently. Awareness raising among the Indo-Tibetan Border Police (ITBP), other security forces, and local herders, who are the major stakeholders in these remote areas, is imperative for the long-term survival of the species and its habitats in this region. As suggested by Ahmad et al. (2016) it is recommended that genetic studies are undertaken to investigate patterns of genetic diversity, relatedness, and population connectivity using mtDNA and nuclear markers in the study populations to determine their relationship with other populations on the Qinghai-Tibet Plateau and identify if any barriers exist.

Acknowledgements

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Tibetan Antelopes in Ladakh, India. Photo: K. Ahmad

A new comprehensive package for the management and analysis of camera trap data for monitoring antelope and other wildlife species

Rajan Amin (Raj.Amin@zsl.org), Tim Wacher (Tim.Wacher@zsl.org)
Conservation Programmes, Zoological Society of London, Regents Park, London

Camera trapping – the use of remotely triggered cameras to photograph wildlife – is emerging as one of the most important methods to monitor terrestrial medium-to-large mammals. It is particularly suited to monitoring forest antelopes. The decrease in camera trap cost, with technological improvement, proven success in monitoring rare and elusive species, as well as whole mammal communities makes camera trapping an important and efficient survey technique for conservation. However, the very large amounts of data generated are frequently only partially analysed because of the difficulties in managing and analysing the thousands of images recorded. One consequence is that important biological information on a range of species captured by the cameras is overlooked.

In order to maximise use of camera trap data the Zoological Society of London (ZSL) has developed a Camera Trap data Analysis Package (CTAP) for managing and processing large volumes of image data efficiently and reliably. The package has been designed to manage multiple surveys using standardised lists of species and camera trap parameters. The package performs a range of survey effort and species level analyses with tabular, graphical, and QGIS and Google Earth map outputs.

Key features of the software package include:

- Survey effort reports.
- Species list (taxonomically ordered with information on habitat, habit, tropic level, adult body weight, IUCN Red List threat status) with number of images, number of events and number of camera stations detected.
- Species rarefaction curves and species richness estimates.
- Species spatio-temporal plots.
- Species trapping rates with standard errors (overall and daily / seasonal).
- Species occupancy modelling (with sites covariates).
- Distribution plots of trapping rates and occupancy (in Google Earth, QGIS and ArcGIS).
- 24-hour activity patterns with radial plot and bar chart outputs.

The package is now extensively being used to analyse camera trap survey data from a range of ZSL and partner sites and habitats including desert systems (Saudi Arabia, Chad Mongolia), grassland systems (India, Nepal, Benin, South Africa) and forest systems (Kenya, Cameroon, Liberia, Guinea, Thailand, Indonesia, Russia). Examples of outputs generated from the analysis package illustrating results for various forest antelope species using the package's species selection options are shown in Figures 1-7.

Future Developments

The following features will be available in version 2 of the software package.

- Image processing tool
- Population density estimates for marked animals (spatially explicit capture-recapture modelling).
- Movement pattern analysis and home range estimation for marked animals.
- Population density estimates for unmarked animals.
- Activity level modelling.
- Diversity measures.
- Species community structure analyses.
- Statistical tests (chi-square, circular statistics etc.).
- Cross survey analyses.
- Standardised reports generation in Word and RTF.

Further information on CTAP is available on https://www.zsl.org/zsl-camera-trap-data-management-and-analysis-package

Acknowledgements: The data outputs used to illustrate analysis results of the camera trapping package in this article derive from reports produced in collaborations between ZSL and Ministère des Forêts et de La Faune (MINFOF) in Cameroon and between ZSL and Kenya Wildlife Service (KWS) in Kenya. The authors thank all members of the field teams in both countries.

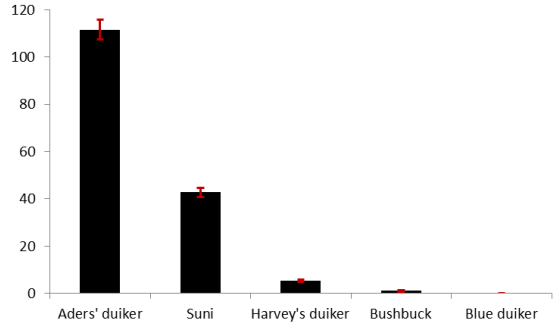

Figure 1. Comparative plot of trapping rates (camera trap events/day x 100, with standard error bars) of selected species; antelopes, Boni National Reserve, coastal Kenya.

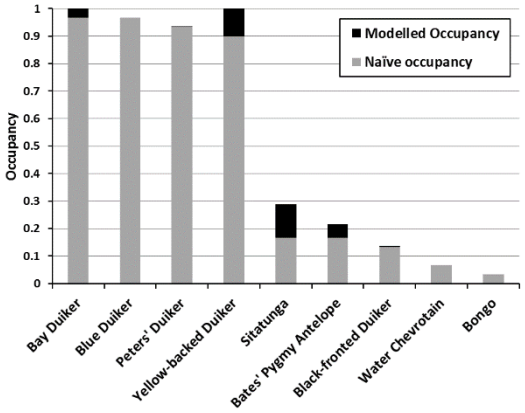

Figure 2. Plot occupancy modelling for selected species; comparing antelope species, based on 40 camera traps in a 2x2 km grid layout, Dja Biosphere Reserve, Cameroon.

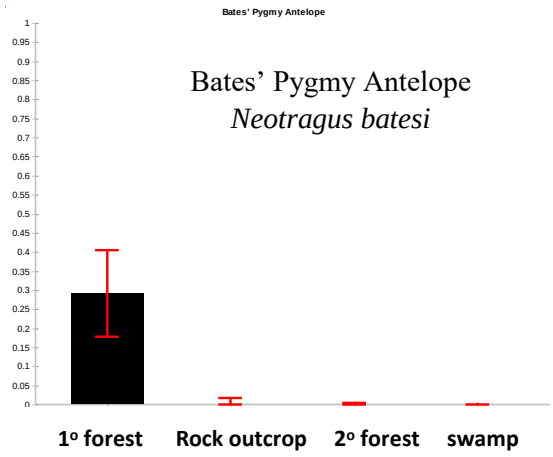

Figure 3. Plot occupancy modelling of camera trap data by categorical covariate (habitat type); Bates' Pygmy antelope, Dja Biosphere Reserve, Cameroon.

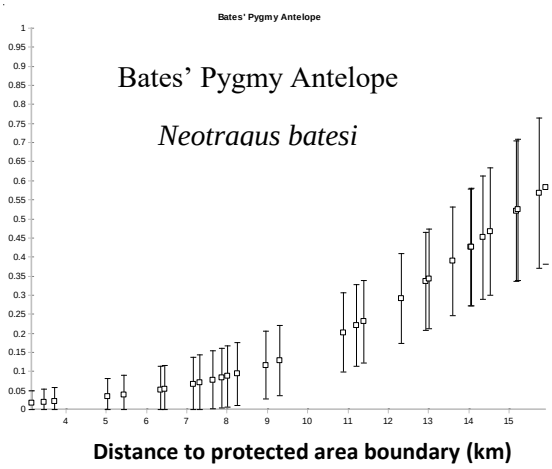

Figure 4. Plot occupancy modelling of camera trap data by numerical covariate (distance from protected area boundary); Bates' Pygmy antelope, Dja Biosphere Reserve, Cameroon.

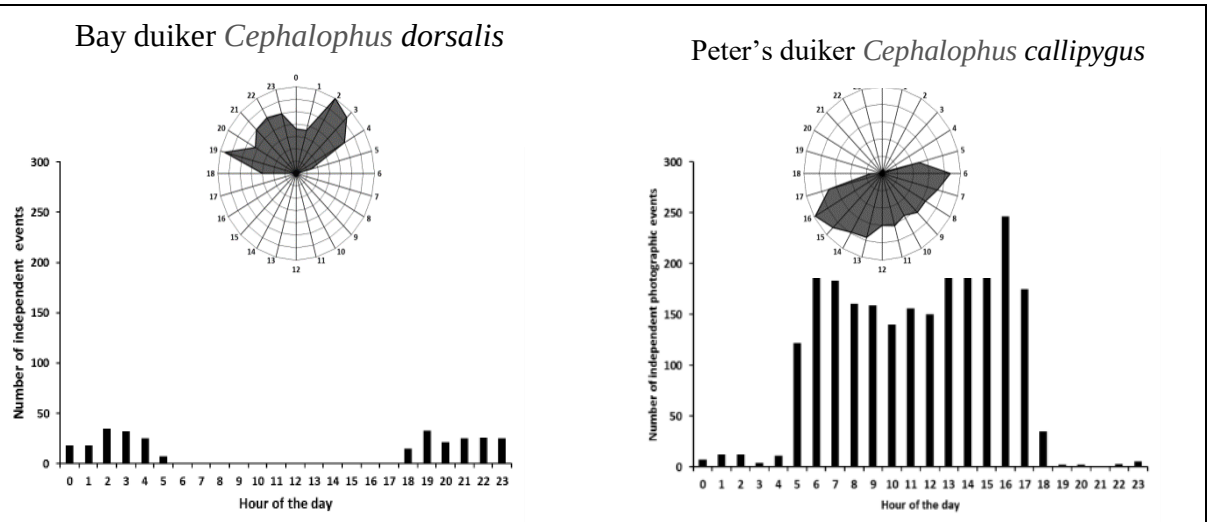

Figure 5. Plot timing of camera trap events (bar-chart or radial); comparison of event frequency and activity pattern of Bay duiker and Peter's duiker, Dja Biosphere Reserve, Cameroon.

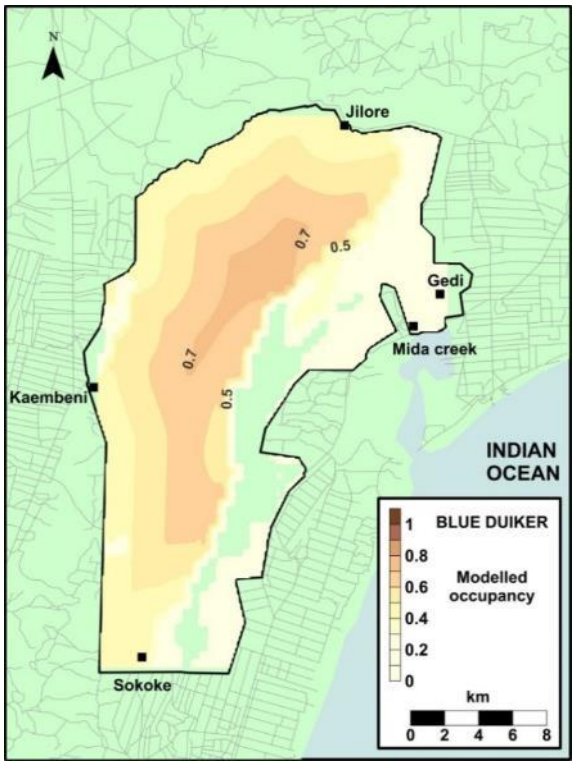

Figure 6. Plot results of occupancy modelling: Blue duiker *Philantomba monticola* occurrence map, Arabuko-Sokoke Forest Reserve, Kenya. Derived from output of CTAP on 46 camera traps using covariates 'distance from protected area boundary' and 'forest habitat type' *(Brachystegia* forest, *Cynometra* forest, mixed forest).

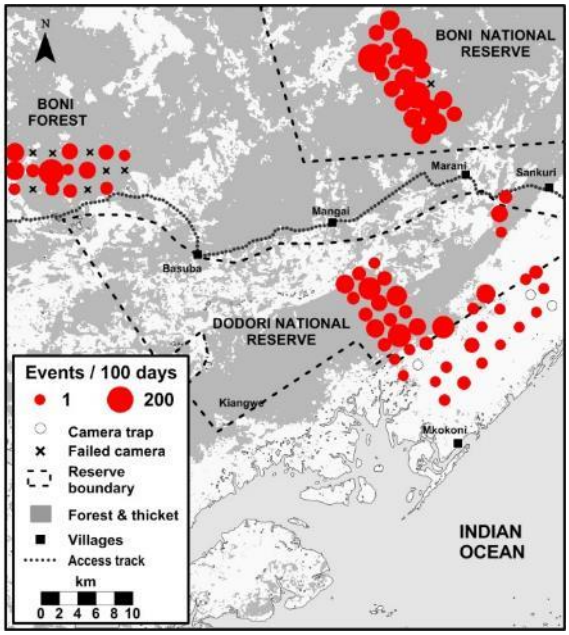

Figure 7. Spatial plot of trapping rates for any selected species; viewed direct on Google earth or through QGIS; Aders' duiker *Cephalophus adersi*, Boni-Dodori forest system, coastal Kenya.

First record of Four-horned Antelope *Tetracerus quadricornis* (De Blainville, 1816) in Deukhuri Valley: First camera trap record outside protected areas of Nepal

Chiranjeevi Khanal[123*], Yadav Ghimirey[1], Raju Acharya[1] and Sanjeev Baniya[3]
[1] *Friends of Nature (FON Nepal);* [2] *IUCN SSC Hyaena Specialist Group;* [3] *Institute of Forestry, Pokhara, Nepal.* [*]*Corresponding Author: email: chiran_khanal2011@hotmail.com*

Abstract
Four-horned Antelope is endemic to the Indian subcontinent. During a camera trapping programme in the Deukhuri valley, Nepal, in 2016 and 2017, the species was recorded in Narayanpur community forest. Past studies show the presence of Four-horned Antelope in Nepal only in Parsa, Chitwan, Bardia and Banke National Parks. This is the first camera trap record in Deukhuri valley of Dang District and also outside protected areas in Nepal, and the finding adds information on the distribution of this species in the country.

Introduction
Four-horned Antelope *Tetracerus quadricornis* (FHA hereafter), is endemic to the Indian subcontinent. It is a solitary herbivore with small body size (Karanth and Sunquist 1992; Leslie and Sharma 2009). It is listed as globally Vulnerable on the IUCN Red List (IUCN SSC Antelope Specialist Group 2017) but is classified as data deficient in the national red list of Nepal since insufficient information is available to make an accurate assessment of the extinction risk of this species in the country (Jnawali et al. 2011). The current population size of FHA in Nepal is unknown. It is listed in the National Parks and Wildlife Conservation Act 1973 as a protected priority species. FHA is believed to be widely distributed with fragmented populations particularly in dry deciduous forest in lowland of Nepal and India (Krishna et al. 2008; Leslie and Sharma 2009; Sharma et al. 2013; IUCN SSC Antelope Specialist Group 2017). According to Leslie and Sharma (2009), the species occurs in east-central Nepal, whereas the IUCN Red List states that FHA occurs only in the western part of Nepal. Presently, they are reported from four protected areas: Bardia National Park, Chitwan National Park, Parsa National Park (previously Parsa Wildlife Reserve) and Banke National Park (Kunwar et al. 2016). Baseline information about their distribution, feeding ecology, habitat requirements, population density and present status in Nepal is lacking (Kunwar et al. 2016). This paper confirms the record of FHA in Deukhuri valley and also outside a protected area in Nepal.

Study area
Dang district is located in the western region of Nepal (28°7'0"N and 82°18'0"E) and covers an area of 2,955 km^2. Dang district consists of two valleys; Dang and Deukhuri Valley, upper and lower valley respectively. Deukhuri valley, also known as "Valley of Hyaenas" consists of 11 village development committees (VDC). Research was conducted in 10 of the VDCs in the valley, covering an area of about 200 km^2. Rapti River flows in between the valley and divides the valley in southern and northern part. Satbariya, Chailahi, Sonpur, Sisahaniya, Lalmatiya are the VDC in northern side whereas Rajpur, Bela, Gadawa, Gangaparaspur, Gobarhardiya and Koilabas lies on south of valley. This Valley is surrounded by forest covered hills that connects Bardiya-Banke and Chitwan National Park through the Churia forests in the Dovan Bottleneck. The valley is connected with Banke National Park in the west and an intact forest in the south connects with Sohelwa Wildlife Sanctuary in India (Khanal 2015). The valley It lies outside of Nepal's protected area system. It has been identified as one of Nepal's Important Bird Areas (IBAs) by BirdLife International (Baral and Inskipp 2005). *Shorea robusta*, *Dalbergia-Accassia* forest are the forest types found here, as well as patches of degraded forest.

Methods
We carried out research focused on Striped Hyena *Hyaena hyaena* in 2016 and 2017 in Deukhuri Valley. The primary methods used were camera-trapping and sign surveys. The study area was divided into grids of 5*5 km^2. Grids were assessed on the basis of forest cover and grids with more than 50% forest cover were selected for camera trapping and sign surveys and those with human settlements, agricultural fields, rivers and

large river banks were excluded. A total of 22 grids were selected for camera trapping. Motion-sensor camera-traps were placed on forest trails, at waterholes and also in areas where carcasses were found opportunistically. A single camera trap was deployed in each grid for a minimum of 15 nights. Camera traps were deployed for 529 trap nights in total. Indirect sign surveys along existing trails were carried out in each grid. covering 1-2 km. Coordinates and altitudes of each record were taken by GPS units (Garmin Etrex 10). Mammals encountered during field work were identified using Baral & Shah (2008).

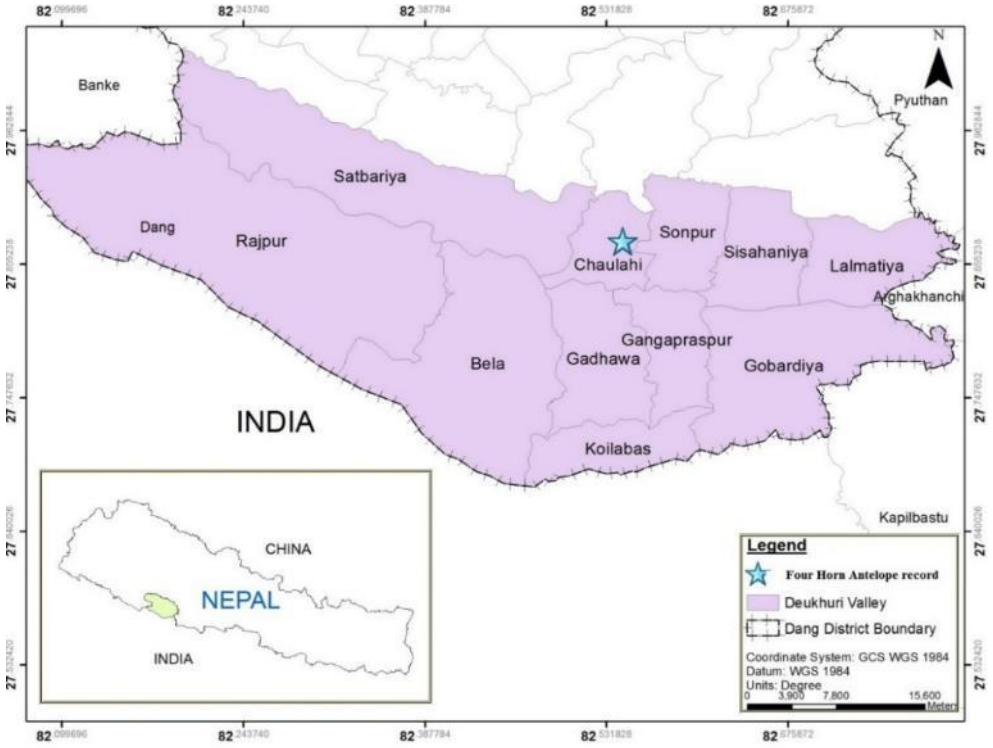

Figure 1. Map showing the FHA record site in Deukhuri Valley.

Results

In total, 13,622 images were obtained. A sub-adult FHA was captured in camera traps in Narayanpur Community forest of Chailahi VDC (now Lamahi Municipality) in Deukhuri Valley, Dang, at an elevation of 240 m on 21 January 2017. Four images of FHA were obtained in a single independent capture on a forest trail near a conservation pond. This community forest is frequently visited by people to collect firewood and fodder and graze cattle, mainly during the day. There was no previous evidence of FHA in the valley (Jnawali et al. 2011, Pokharel 2016). This finding adds information on the distribution of this species in Nepal and represents the first camera-trap record outside protected areas in Nepal. No other information on FHA in this and nearby forests is available, so a detailed study of the status and distribution in the valley is recommended for a long-term conservation of this species fodder and graze cattle, mainly during the day. There was no previous evidence of FHA in the valley (Jnawali et al. 2011, Pokharel 2016). This finding adds information on the distribution of this species in Nepal and represents the first camera-trap record outside protected areas in Nepal. No other information on FHA in this and nearby forests is available, so a detailed study of the status and distribution in the valley is recommended for a long-term conservation of this species.

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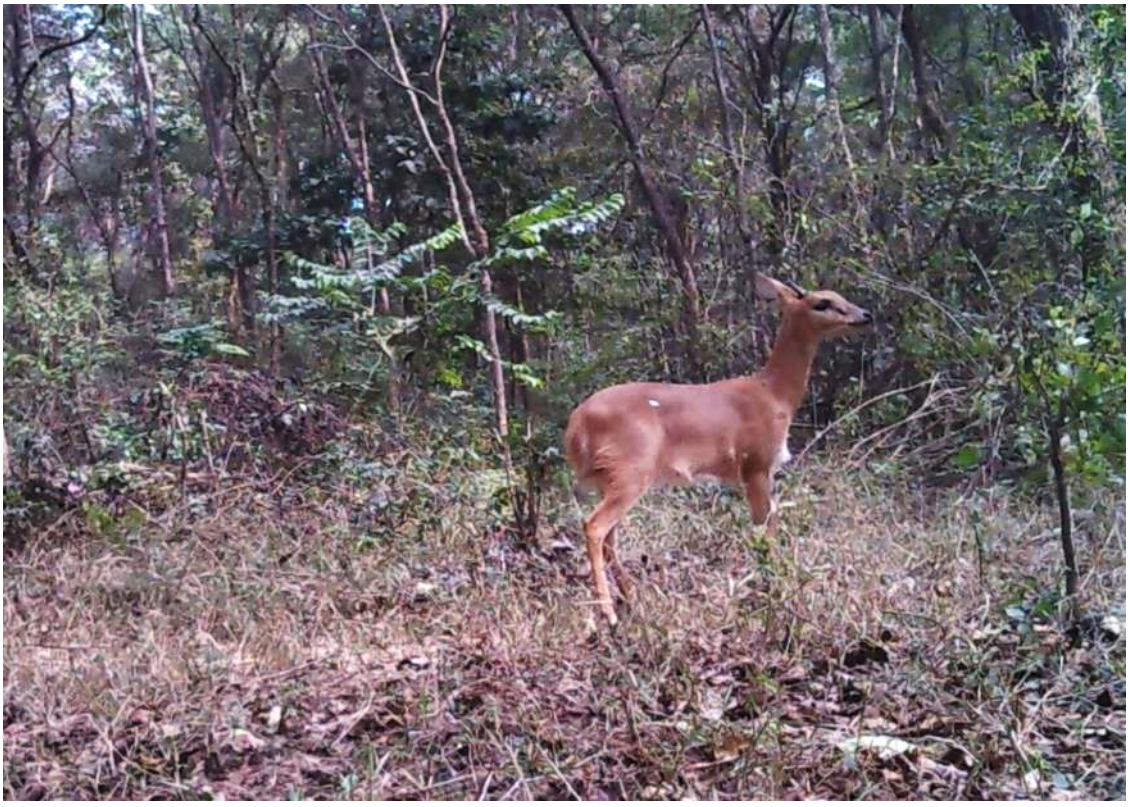

Figure 2. Four-horned Antelope, camera-trapped in Deukhuri Valley

Antelope survey in Lama Forest, Benin, West Africa

Etotépé A. Sogbohossou & Barthélémy D. Kassa
Laboratory of Applied Ecology, University of Abomey-Calavi (LEA/UAC), BENIN. etotepe@gmail.com

Lama gazetted forest is one of the most important protected areas in southern Benin that still hosts some wildlife populations. Located between 6°55'–7°00'N and 2°04–2°12'E, this forest covers 16,250 ha. It is composed of a core area which is the original forest (4,777 ha) surrounded by tree plantations (Figure 1). Local people have been relocated in few settlements inside the forest. The forest has a high plant diversity (Sinsin et al. 2003) and serves as habitat to various species of wildlife among which the endemic red-bellied guenon *Cercopithecus erythrogaster* ssp. *erythrogaster* and several antelopes species (Kassa & Sinsin 2003). The forest is managed by the national timber office (Office National du Bois ONAB in French). This office manages the plantations and pays guards to protect the core zone. Southern Benin is densely populated and the Lama forest is hypothesized to be the main source of animals that fuel the bushmeat trade in this part of the country (Sogbohossou & Kassa, 2016). We conducted a short survey in 2015 in the core area of the forest to assess the biodiversity and check if the bushmeat trade has affected it.

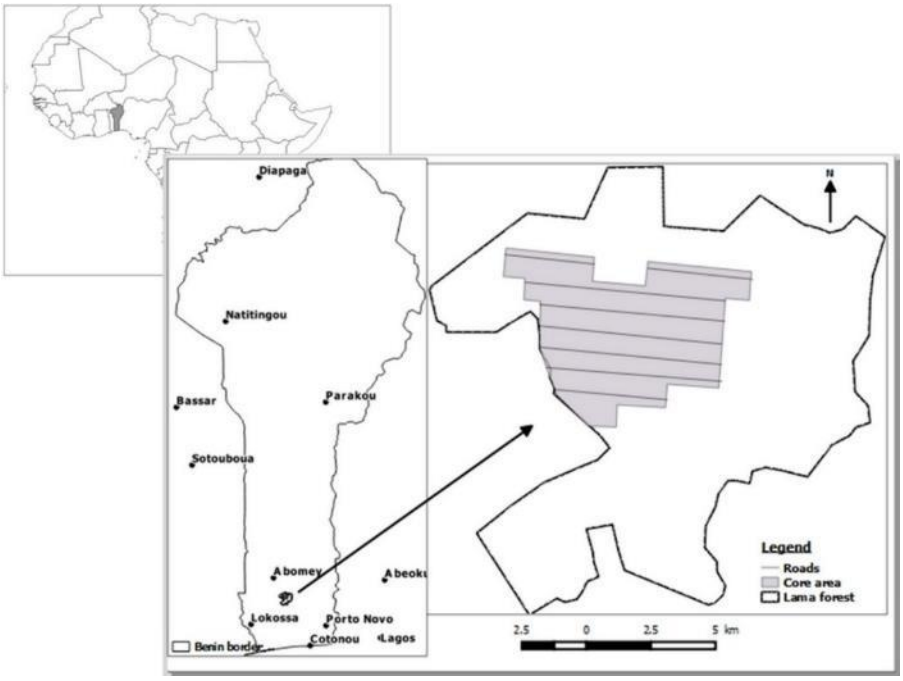

Figure 1. Location of Lama forest in Benin

We carried out a camera trapping survey in July and August 2015, deploying 43 camera stations along trails. One camera (Bushnell Trophy Cam, Browning Dark Ops HD, Moultrie M880i and M-990i) was placed at each station. Cameras were set to record the date and time of each capture and worked 24 hours a day. Each station was surveyed 20–32 days with a total of 1152 camera trap days. We calculated the capture rate (the number of pictures per 100 days of trapping) and the naïve occupancy, which is the proportion of stations at which a species was captured. We obtained 252 pictures with recognizable objects, of which 24.6% were pictures of antelopes. A total of 16 species belonging to 12 families and 6 orders were captured. Mammals comprised 68.8% of the captured species. We got 39 and 23 pictures of duikers and Bushbuck respectively, representing a capture rate of 3.39 and 2 photographs 100/day for the two species. However Bushbuck were more widely distributed than duikers in the forest, with duikers present in 13.95% of the sites and bushbuck in 32.56% of the surveyed sites. Poachers were found on 30.23 % of the sites with a capture rate of 2 photographs/100 days. The only duiker species correctly identified on

pictures was Maxwell's Duiker *Philantomba maxwelli*. Other species captured were mongooses, genets *Genetta* spp., African Palm Civet *Nandinia binotata*, Striped Ground-squirrel *Xerus erythropus*, Crested Guineafowl *Guttera pucherani*, Bushpig *Potamochoerus porcus*, Cane Rat *Thryonomyx swinderianus*, Double-spurred Francolin *Francolinus bicalcaratus*, Mona Monkey *Cercopithecus mona*, Nile Monitor lizard *Varanus niloticus*, Crested Porcupine *Hystrix cristata*, Patas Monkey *Erythrocebus patas*, Gambian Rat *Cricetomys gambianus* and snakes. Mongooses, duikers and genets had the highest capture rate followed by bushbuck and poachers. Mongoose, genets and Bushbuck have the widest distribution followed by poachers.

Photo 1. Aerial view of Lama Forest (the teak plantation on the left and the natural forest on the right) ©LEA/UAC

These preliminary results showed that the Lama Forest hosts an appreciable wildlife diversity. However, the capture rate is quite low compared to findings in other forests in Africa (Rovero & Marshall 2009; Mugerwa et al. 2012). Some species expected were not found in the pictures. Several years ago, more antelope species were recorded in Lama Forest through questionnaires and direct and indirect transect methods. These were Royal Antelope *Neotragus pygmaeus*, Yellow-backed Duiker *Cephalophus silvicultor*, Black Duiker *Cephalophus niger* (Kassa and Sinsin 2003; Djossa et al. 2010). Sitatunga *Tragelaphus spekei* was also said to be present in the forest (Djossa et al. 2010). Buffalo was reported to be extinct quite some time ago in the forest. The absence of these species from pictures does not mean they are absent from the site. However if these antelopes are still present in the area, their absence from captures suggests that they occur in very low density. Lama Forest is hypothesized to be one of the main source of the bushmeat trade in southern Benin (Sogbohossou & Kassa 2016). The relatively low capture rate and the absence of several expected species indicate that poaching has a negative impact on the wildlife populations of the forest. The frequent presence of poachers on pictures confirm this threat. During discussions with local people, several hunters in the area also reported killing wildlife in farms. It will be important to survey the plantations, which separate the core zone from farms and villages. The current research did not take into account this part of the forest, in order to reduce the loss of cameras. A survey in this area will confirm if it serves as corridor for wildlife movement from the core area to farms and if farms and also plantations which are extensively used by population play the role of a sink area for wildlife. On the other hand, it is necessary to

increase the duration of the camera trap survey in the Lama Forest in order to increase the chance of recording all species present. Indeed, in forested areas, Tobler et al. (2008) advised surveying for at least 1600–2000 trapping days in order to detect rare species.

While some of the antelopes found in Lama Forest, such as Bushbuck, are found in protected areas both in north and south Benin, others are limited to the southern part of the country which is densely populated with fewer protected areas than in the north. The human pressure and the importance of bushmeat in southern Benin make it necessary to increase efforts to guarantee the conservation of these species in the few existing protected areas. Species such as Maxwell's Duiker depend greatly on the Lama Forest for their survival in southern Benin.

A continuous monitoring of the diversity in the Lama ecosystem and of bushmeat trade in the region will provide important baseline data to improve policies and conservation actions. It is urgent to take more appropriate measures to conserve the diversity in this unique ecosystem of southern Benin so that it could continue to play the role of biodiversity reservoir.

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Photo 2. Tragelaphus scriptus in Lama Forest. © LEA/UAC

Photo 3. *Philantomba maxwelli* in Lama Forest. © LEA/UAC

Antelopes in Garamba National Park, DRC

Mathias D'haen
Czech University of Life Sciences. Email: mathias@dhaen.be

Garamba National Park, nestled in the north-eastern corner of the Democratic Republic of Congo (Fig. 1) and once home to the world's last Northern White Rhinos *Ceratotherium simum cottoni*, has, sadly enough, regularly made news with its war-torn environment. With increased efforts by African Parks and Institut Congolais pour la Conservation de la Nature (ICCN), the Park's future now looks bright again and research and monitoring activities are being developed.

The Garamba complex consists of Garamba National Park (5,133 km^2) and three adjacent hunting reserves totalling a further area of 14,793 km^2. Established in 1938 it is one of Africa's oldest National Parks and was designated a UNESCO world heritage site in 1980. The Garamba complex just falls outside the country's famous rainforest, with a core area consisting of open savannah and densely forested peripheries.

Fig. 1. Garamba National Park, in the north-eastern corner of the DRC

Garamba's most abundant large mammal is the African buffalo *Syncerus caffer* with a total of 6728 animals counted during the last aerial survey in 2017. Herds of up to 300 individuals are regularly recorded. Even though buffaloes occur all over the Park they are most abundant in the south-central sector, where they reach densities of 7.2 buffaloes per km^2. Lower numbers are noted in the peripheries and in the north of the Park where they suffered high levels of poaching in the past. It is expected that buffalo populations will start growing again in these regions making the species a good indicator for the anti-poaching efforts of the Park.

What follows is an overview of the antelope species occurring in the Park and their status based on a combination of historical and recent information. Unless stated otherwise, their status has remained the same. Historical records are based on large mammal surveys by Verschuren in 1949-1952. When a subspecies name is shown in brackets its taxonomy is unclear or the Latin name is as used by Verschuren.

Red-flanked duiker *Cephalophus rufilatus (rubidior)*

Not in open savannah. Restricted to the wooded savannah of the peripheries.

Blue duiker *Philantomba monticola* (used to be: *Cephalophus monticola aequatorialis)*

Restricted to gallery forests and rarely seen, probably due to their elusive life-style.

Bush duiker *Sylvicapra grimmia (roosevelti)*

Uncommon and difficult to spot during wet season.

Yellow-backed duiker *Cephalophus silvicultor*

Gallery forests and the more densely vegetated parts of the park. Rarely seen but good densities occur in the adjacent peripheries of the park.

Bohor reedbuck *Redunca redunca (dianae)*

Common, though difficult to spot during wet season.

Oribi *Ourebia ourebi*

Common, though difficult to spot during wet season.

Waterbuck *Kobus ellipsyprimnus defassa* (used to be *Kobus defassa harniei*)

One of the most common antelopes in and around Garamba NP.

Uganda Kob *Kobus kob thomasi* (used to be: *Adenota kob alurae*)

Probably the most common antelope in the Park. Restricted to the open savannah.

Roan antelope *Hippotragus equinus (bakeri)*

Uncommon.

Lelwel Hartebeest *Alcelaphus buselaphus lelwel* (used to be: *A. lelwel lelwel*)

One of the most common antelopes in and around Garamba NP.

Bushbuck *Tragelaphus scriptus (dianae)*

Common. Not so much in the open savannah, more in the wooded savannah.

Sitatunga *Tragelaphus spekei (gratus)*

Historical status 'rare'. Current status is difficult to assess, given its elusive lifestyle but it is believed that the species is more common than thought. Two confirmed observations in 2017.

Bongo *Tragelahus euryceros euryceros*

Historically recorded by only one specimen that was found inside a dead python! Recent status is unclear, but tracks have been found.

Giant eland (Derby's eland) *Tragelaphus derbianus gigas* (used to be: *Taurotragus*)

Historical: rare. Current: most likely extinct.

Water Chevrotain *Hyemoschus aquaticus*

Recently discovered through a camera trap. Probably not uncommon and only recorded now because their nocturnal life style.

Reference

Verschuren J. (1958) *Ecologie et Biologie des grands mammifères. Exploration du Parc National de la Garamba*. Institut des parcs nationaux du Congo Belge. Bruss

Aerial view of Garamba NP. Photo: Mathias D'haen

Antelopes in Garamba NP: Top left; *Cephalophus rufilatus*; top right: *Tragelaphus spekii*; Bottpm left: *Hippotragus equinus*; bottom right: *Tragelaphus scriptus*. Below: African Buffalo. All photos: Mathias D'haen.

Antelope News

Black Lechwe *Kobus leche smithemani*
A late wet season aerial survey was commissioned by African Parks Network (APN) and carried out by ASG member Petri Viljoen in early 2017. 15,783 Black Lechwe were counted in the 223 km^2 survey area resulting in an overall population estimate of 45,313 (44,763–45,863). The survey methodology used was a video-based sample and the results confirm that this technique produces accurate and reliable results.
Source: Viljoen, P. 2017. Bangweulu Wetlands Zambia. Black Lechwe Survey May 2017. African Parks Network.

Beisa Oryx *Oryx beisa beisa*
A recent analysis of aerial survey data in Kenya showed that Beisa Oryx numbers had fallen significantly and a change in Red List Category to Endangered has been proposed. Aerial surveys undertaken recently as part of the Northern Rangeland Trust's Beisa Oryx Recovery Program have located a large sub-population of Beisa Oryx in the eastern part of Nakuprat-Gotu Community Conservancy, which adjoins Shaba National Reserve. Numbers are estimated as at least 630, occupying an area of c. 800km^2, representing a higher than average density.
Source: King, J., Craig, I., Kuraru, S., Wandera, A. 2017. Nakuprat-Gotu Community Conservancy Aerial Surveys September 2016 and June 2017. Northern Rangelands Trust. 12 pp.

Saiga *Saiga tatarica*
Saiga News Issue 22 was published in October 2017. It contains articles on many aspects of saiga conservation, including an update on Mongolian Saiga status, illegal trade, training dogs to detect saiga products and several other topics. *Saiga News* is published in six languages and is available to download from the websites below.
Source: http://www.saigaresourcecentre.org, www.saiga-conservation.com

Mongolian Saiga ***Saiga tatarica mongolica***
More bad news for Mongolian Saiga, following the outbreak of PPR earlier in 2017 that killed an estimated 54% of the Mongolian Saiga population (see *Gnusletter* 34#1 and *Saiga News* 22). A survey in October 2017 by a team from WWF-Mongolia and saiga rangers found that rangeland conditions were totally degraded and inadequate in key areas of habitat such as Shargiin Gobi, Khuren Gol, and Uguumur after a very dry summer with late rainfall in most of saiga range. The few remaining saiga individuals have become scattered due to lack of forage as pastureland is severely overgrazed. A similar harsh winter to 2002 could be expected this year according to saiga researchers and conservationists, posing a severe threat to the remaining saiga. WWF-Mongolia will distribute hay and build winter shelters, as they have done for the last two decades.
Source:http://mongolia.panda.org/en/?uNewsID =315712 (Posted on 06 November 2017)

Tibetan Antelope *Pantholops hodgsonii*
The Red List status of Tibetan Antelope was recently changed to Near Threatened following intensive protection methods and an increase in the wild population (*Gnusletter* 34#1). However, a report to the CITES Standing Committee meeting 27 November-1 December 2017 shows that illegal trade in wool products has not stopped. Seizures of illegally traded shahtoosh shawls are increasing in Europe, with a total of 159 shawls seized in Switzerland during 2010-2015. It is not clear how many of the seizures involved new products and how many were 'existing stocks' but this evidence demonstrates that constant vigilance is needed.

At the 26th meeting of the INTERPOL Wildlife Crime Working Group hosted in Singapore in November 2015, 'Operation Ring', was initiated, which provides a platform for law enforcement cooperation between source, transit and destination countries to combat illegal trade in parts and derivatives of Tibetan Antelope.

INTERPOL hosted an "Operation Ring" workshop in Lyon, France, 30 June-1 July 2016, in close cooperation with the CITES Management Authority of Switzerland and with funding made available through the International Consortium on Combating Wildlife Crime (ICCWC). The workshop brought together representatives from CITES authorities and enforcement agencies from 10 Parties (China, Germany, India, Kuwait, Nepal, Pakistan, Spain, Switzerland, the United Kingdom of Great Britain and Northern Ireland, and the United States of America), various experts, and representatives from the CITES Secretariat and INTERPOL. The aim of the

workshop was to exchange information, knowledge and experiences on illegal trade in parts and derivatives of Tibetan Antelope, as well as to train participants in identification of shahtoosh shawls containing fibres of wool from Tibetan Antelope. Subsequent to the workshop, a Project Ring Workshop Report was developed. The initiatives taken by Switzerland and the INTERPOL Wildlife Crime Working Group are an excellent example of strengthening enforcement cooperation at a global level.
Source: CITES Standing Committee 69 Doc. 59.

Grey Rhebok *Pelea capreolus*
This species is endemic to southern Africa and most of the population occurs in South Africa. Reports of its presence in southern Namibia have not been confirmed until recently when John Irish located a reliable record in the Sperregebiet.
Source: Namibia Biodiversity Database http://biodiversity.org.na/taxondisplay.php?nr=115

UNESCO World Heritage Sites (WHS)
Two important antelope landscapes have recently been designated as World Heritage Sites by UNESCO. Hoh Xil Nature Reserve, situated on the Qinghai-Tibet Plateau in China, harbors a key population of Tibetan Antelope *Pantholops hodgsonii* as well as Tibetan Gazelle *Procapra picticaudata*. The Landscapes of Dauria WHS covers most of the Daurian Steppe in eastern Mongolia and adjoining areas of Russia and China, which is the core habitat for Mongolian Gazelle *Procapra gutturosa.*

W National Park The current WHS covers the Nigerien sector of W NP and has now been extended to include the whole W-Arly-Pendjari Complex, a transboundary protected covering adjoining parts of Niger, Burkina Faso, and Benin. This is probably the most important protected area in the whole of the West African Savanna zone and protects several threatened antelopes, including Western Hartebeest *Alcelaphus buselaphus major*, Korrigum *Damaliscus lunatus korrigum*, Buffon's Kob *Kobus kob kob*, and Red-fronted Gazelle *Eudorcas rufifrons*, in addition to several more common species.
Source: whc/unesco.org/en/newproperties

Furthermore, Comoé NP in Côte d'Ivoire was removed from the list of World Heritage Sites In Danger on 2 July 2017. Comoé is another important site for antelopes, the largest single national park in West Africa, covering more than 11,400 km^2 and containing a wide range of savanna and forest mosaic habitats.
Source: whc.unesco.org/en/list/227

Pendjari National Park, Benin
African Parks assumed management of Pendjari NP in 2017, to revitalise the last large reserve in west and central Africa, and create a thriving wildlife destination. The park, with an area of 4,800 km^2, is part of the W-Arly-Pendjari (WAP) complex which spans Benin, Burkina Faso and Niger, and is the largest remaining intact natural ecosystem in the whole of West Africa. Pendjari is home to iconic species including elephant, cheetah, lion, buffalo, antelope and a rich diversity host of other wildlife. Funding is being provided by the Government of Benin and several other donors.
Source: www.african-parks.org/the-parks/pendjari

Luengue-Luiana and Mavinga National Parks, Angola
These two NPs in Cuando-Cubango Province together cover 84,400 km^2 and form part of the Kavango-Zambezi Transfrontier Conservation Area (KAZA), Africa's largest conservation landscape, encompassing parts of south-east Angola, northern Botswana, north-east Namibia, south-west Zambia and western Zimbabwe. The TFCA is a stronghold for large carnivores and contains Africa's largest populations of African buffalo and wild dog as well as half of the elephant population. An extensive camera trap survey of Luengue-Luiana NP and Mavinga NP has been undertaken by Panthera. The results showed that Sable and Roan were widely distributed across the area. Also recorded were Greater Kudu, Common Eland, Bushbuck, Sitatunga, Impala, Southern Reedbuck, Blue Wildebeest, Oribi, Steenbok and Bush Duiker.
Source: Funston, P., Henschel, P., Petracca, L., Maclennan, S., Whitesell, C., Fabiano, E., Castro, I. 2017. The distribution and status of lions and other large carnivores in Luengue-Luiana and Mavinga National Parks, Angola. KAZA TFCA Secretariat. 60 pp.

Published articles

Dark grey gazelles *Gazella* (Cetartiodactyla: Bovidae) in Arabia: Threatened species or domestic pet?

Torsten Wronski, Hannes Lerp, Eva V. Bärmann, Thomas M. Butynski, Martin Plath (2017). *Hystrix, the Italian Journal of Mammalogy* 27: doi:10.4404/hystrix-28.1-11816.

Abstract

True gazelles (genus *Gazella*) are a prime example of a mammalian group with considerable taxonomic confusion. This includes the descriptions of several dark grey taxa of questionable validity. Here, we examined captive dark grey putative Neumann's gazelle *Gazella erlangeri*. Our concerted efforts to retrieve mitochondrial sequence information from old museum specimens of two dark grey gazelles, putative *G. erlangeri* and putative Muscat gazelle *G. muscatensis*, were unsuccessful. We did, however, find the mtDNA haplotypes of extant putative *G. erlangeri* to be nested within the haplotype variation of the Arabian gazelle *G. arabica*. The observed population genetic divergence between *G. arabica* and putative *G. erlangeri* (based on 11 nuclear microsatellites) was driven by genetic impoverishment of putative *G. erlangeri*. These results, along with morphological signatures of domestication (e.g., reduced brain case size), suggest genetic bottle necks and domestication effects as a consequence of prolonged captive breeding. Three hypotheses are discussed: (a) *G. erlangeri* and/or *G. muscatensis* are valid species but are now extinct; (b) one or both taxa represent phenotypic variation within *G. arabica* and, therefore, are synonyms of *G. arabica*; and (c) captive stocks, exhibiting the effects of domestication and inbreeding, are the sources for the descriptions of *G. erlangeri* and *G. muscatensis*. As concerns the conservation of gazelles, based on current knowledge, we strongly advise against using putative *G. erlangeri* for any introduction initiative but recommend the continued captive management of putative *G. erlangeri*.

Open access: http://www.italian-journal-of-mammalogy.it/article/view/11816/pdf

Conservation implications of wildlife translocations; The state's ability to act as conservation units for wildebeest populations in South Africa.

Nicole Benjamin-Fink and Brian K. Reilly (2017) *Global Ecology and Conservation* 12: 46e58

Abstract

Wildlife translocations have historically assisted in re-establishing species in areas of extinction and are currently employed in over 50 countries. Ironically, they may also be responsible for the extinction of pure genetic lineages via hybridization, thereby negatively impacting endangered, indigenous, and rare species. Due to recent evolutionary divergence, black wildebeest (*Connochaetes gnou*) and blue wildebeest (*Connochaetes taurinus*) can mate and produce fertile offspring when sympatric. A total of 6929 translocated black and blue wildebeest from 273 private ranches and 3 provincial protected areas protected (PPAs) were documented over 5 years, across 5 South African provinces. We analyzed dispersal patterns and wildlife ranching economics to identify conservation implications and to infer if translocations are likely to persist in their current form. Findings indicate (1) 58.45% of sampled private ranches manage for both wildebeest populations, (2) blue wildebeest males are primarily translocated, (3) wildebeest are introduced across provincial lines, (4) wildebeest are introduced to within and amongst the private and commercial industry from multiple sources, and (5) wildebeest revenue accounted for 20.8% of revenue generated from all wildlife translocations. Unwanted conservation implications concern ecological integrity, genetic swamping, and regulatory efficiency. We caution against risks posed by the game industry upon the PPA's ability to function as nature conservation units and act as stocking sources and the plausibility that black wildebeest populations incorporate varying degrees of introgressive hybrids. Moreover, wildebeest account for 1/5 of revenue generated from all game translocations. This is indicative of its likelihood to persist in their current form, thereby

inducing hybridization and facilitating outbreeding depression. We caution that concerns are likely to worsen if no intervention is taken. Lastly, we coin the concept of Ecological Sustainable Network (ESN); we designed a framework for standardizing procedures to advance effective wildlife translocation practices worldwide. *Open access:* http://www.sciencedirect.com/science/article/pii/S2351989417301361

Survival estimation of a cryptic antelope via photographic capture–recapture

Marshal, J.P. (2017). *Journal of African Ecology* 55(1): 21-29.

Abstract

Adult survival is a primary determinant of abundance and dynamics of large herbivore populations. For species that are inconspicuous, however, accurate survival estimation depends on accommodating low detection probability. For species with individually recognizable markings, photographic capture–recapture (CR) provides an approach to estimate population parameters while accounting for imperfect detection. I investigated the use of photographic CR for a cryptic large herbivore, the nyala, in a region of Hluhluwe–iMfolozi Park, South Africa. I conducted photographic sampling based on the closed robust design, with 5–6 daily sampling occasions nested within three week-long sampling periods, which delineated one dry and one wet season. Detection differed between sexes: encounter probability of female adults depended on whether individuals fell into high-encounter (seasonal range: 0.61–0.71) or low-encounter (seasonal range: 0.29–0.40) groups, whereas male adults had a constant encounter probability of 0.39 per day. For both sexes, monthly survival probability was ≥0.93 and did not differ appreciably between seasons or sexes. Given the role of survival in population dynamics, photographic CR has the potential to provide survival estimates for cryptic large herbivores that lack such information.

Night and day: evaluating transect methodologies to monitor duikers in the Dzanga-Sangha Protected Areas, Central African Republic

Jost Robinson, C.A., Zollner, P.A., Kpanou, J.B. (2017). *African Journal of Ecology* 55: 222-232.

Abstract

Across the Congo Basin, human hunting pressure poses the biggest threat to small- and medium-bodied forest ungulates (genus *Philantomba* and *Cephalophus*, commonly known as duikers). The exploitation of these species has cascading effects on larger ecosystem processes, as well as on human subsistence practices. This study compares encounter rates and estimated population densities of duiker species, specifically *Philantomba monticola* (blue duiker) in the Dzanga-Sangha Protected Areas (APDS), Central African Republic (CAR). Data were collected using direct observations of individual animals during diurnal (135 km) and nocturnal (150 km) transects in the APDS, with abundance estimates produced using DISTANCE software. Transect data demonstrate that within hunted forests similar to APDS, nocturnal rather than diurnal transects yield more individual observations of ungulates. Despite hunting pressure in the region, estimates presented for APDS suggest some of the highest density estimates reported for blue duikers in western and central Africa (58.6 blue duikers per km^2). This study directly contributes current regional data on the status of duiker populations at APDS and in the larger Sangha Trinational Landscape (TNS, UNESCO). More broadly, we highlight the potential importance of nocturnal transect data to the development of adaptive management regimes in hunted forests.

Abundance, Distribution and Population Structure of Mountain Nyala (*Tragelaphus buxtoni*) in Hanto Controlled Hunting Area, Southeastern Ethiopia

Worku, D. and Datiko, D. (2017). *Journal of Biodiversity & Endangered Species* 5: 190. doi: 10.4172/2332-2543.1000190 (open access)

Abstract

An investigation on abundance, distribution and population structure of endemic and endangered mountain nyala (*Tragelaphus buxtoni*) was carried out in Hanto controlled hunting area between 2015 and 2016 for both wet and dry seasons. The objective of investigation was to compile baseline data on abundance, distribution and population structure of mountain nyala in the controlled hunting area. To achieve the objective, five major habitat types (Erica vegetation, Woodland, Bamboo forest, Riverine forest and Grassland habitat) were identified and 21% of each habitat was surveyed. Sample counts of

mountain nyala was carried out using random line transect sampling method in an area of 39.9 km^2 from the total area of 190 km^2 to estimate the population size and to identify their distribution. The estimated populations of mountain nyala were 531.9 ± 49.3 individuals. Male mountain nyala comprised 37.5%, females were 50.9% and young of both sexes were 11.6% of the total population. The male to female sex ratio was 1:1.36. Age structure was dominated by adults, which constituted 61.2% of the total population. The animals were distributed in all the five habitat types. Hence, the study revealed that, the controlled hunting area harbors significant populations of endemic mountain nyala. As a result, it can serves not only as hunting concession but also as an important core protected area for the country's wildlife conservation and tourist attraction area in the future.

Diurnal activity budget of African buffalo (*Syncerus caffer* Sparrman, 1779) in Chebera Churchura National Park, Ethiopia.

Megaze, A., Balakrishnan, M. and Belay, G. (2016). *African Journal of Ecology* doi: 10.1111/aje.12359

Abstract

One of the fundamental questions in animal ecology concerns the activity pattern of animals and the environmental and intrinsic factors that influence such dynamics. This study tested the hypotheses that activity time budgets of the African buffalo appeared to vary by season and times of day and predicted that buffalo would express unequal proportion of time for different activity patterns during the wet and dry seasons in Chebera Churchura National Park (CCNP). An investigation on the diurnal activity budget of the African buffalo was carried out during the wet and dry seasons of 2012–2014 in the Chebera Churchura National Park, Ethiopia, using focal-animal sampling method. Buffalo spent a greater proportion of the time in feeding and resting/ruminating activities in both the wet and dry seasons. Feeding and resting (lying down and standing) were the predominant activities (87.14% of the diurnal active period), 48.95% time spent feeding during the dry season and 44.91% during the wet season. There was a significant decrease in feeding and an increase in resting from dry seasons to wet seasons. Daytime grazing and resting periods during the wet season were estimated to be 5.39 h and 4.98 h, respectively. Morning and the late afternoon activity peaks were more pronounced during the dry season than the wet season. Therefore, feeding and resting time was influenced by the time of day and the seasons. But there were no significant differences in time allocation for other activities in both the wet and dry seasons. The study has implications for understanding animal activity budget across species, particularly relationships between temperature and season.

Impacts of taxonomic inertia for the conservation of African ungulate diversity: an overview Spartaco Gippoliti, Fenton P. D. Cotterill, Dietmar Zinner, and Colin P. Groves. *Biological Reviews 2017*

Abstract

We review the state of African ungulate taxonomy over the last 120 years, with an emphasis on the introduction of the polytypic species concept and the discipline's general neglect since the middle of the 20th century. We single out negative consequences of 'orthodox' taxonomy, highlighting numerous cases of neglect of threatened lineages, unsound translocations that led to lineage introgression, and cases of maladaptation to local conditions including parasitic infections. Additionally, several captive breeding programmes have been hampered by chromosome rearrangements caused by involuntary lineage mixing. We advocate that specimen-based taxonomy should regain its keystone role in mammal research and conservation biology, with its scientific values augmented with genomic evidence. While integration with molecular biology, ecology and behaviour is needed for a full understanding of ungulate alpha diversity, we stress that morphological diversity has been neglected despite its tremendous practical importance for some groups of 'utilizers' such as trophy hunters, wildlife tourists and conservationists. We conclude that there is no evidence that purported 'taxonomic inflation' has adverse effects on ungulate conservation: rather, it is taxonomic inertia that has such adverse effects. We stress that sound science, founded on robust taxonomy, should underpin effective sustainable management (hunting, ranching, captive breeding and reintroduction programmes) of this unique African natural resource.

Keywords: conservation, taxonomy

Recovery of ungulate populations in post-civil war Akagera National Park, Rwanda

Ann Apio; Martin Plath; Torsten Wronski

Journal of East African Natural History 104(1&2): 127–141 (2015)

Abstract

Following the 1991–1995 civil war in Rwanda, large parts of Akagera National Park (NP) and the adjacent Mutara Game Reserve were endowed by government to returning war refugees for cattle grazing. In 1997, official degazettement reduced the area covered by these two protected areas by 60% (from 2800 km² to 1120 km^2). This study reports trends in population sizes and densities of ungulates in modern Akagera NP (1120 km²), with a focus on the more common ungulates (impala, topi, zebra, buffalo, waterbuck, and warthog). Data from previous surveys are compared with our 2010–2014 road strip counts using distance sampling. A decline of ungulate populations during the civil war, followed by recovery several years after reduction of the size of the Park, is evident. The ungulate populations show different trends in size in recent years, suggesting that the carrying capacity has been reached for some species.

Keywords: density estimates, distance sampling, protected area reduction, antelopes, post-conflict trend

Ecotypes and evolutionary significant units in endangered North African gazelles

Teresa L. Silva, Candida G. Vale, Raquel Godinho, Amina Fellous, Yves Hingrat, Paulo C. Alvesi, Teresa Abaigar and Jose C. Brito

Biological Journal of the Linnean Society, 2017, XX, 1–15. With 4 figures.

Abstract

Conservation planning of threatened taxa relies upon accurate data on systematics, ecological traits and suitable habitats. The genus *Gazella* includes taxa with distinct morphologies and ecological traits, but close phylogenetic relationships. The North African *Gazella cuvieri* and *Gazella leptoceros loderi* share morphological and physiological characters but the former is darker and found in mountain areas, while the latter is lighter and associated with sand dunes. Here we aim to assess the genetic distinctiveness of these taxa, to characterize their ecological niches and to identify potential occurrence areas, by analysing 327 samples across North-West Africa. Phylogenetic analyses based on mitochondrial (*CYTB*) and five nuclear gene fragments (*KCAS, LAC, SPTBN1, PRKCI* and *THYR*) show that both taxa comprise a single monophyletic group. However, ecological niche-based modelling suggests that populations of these taxa occupy distinct geographic areas and specific environments. Predicted areas of sympatry were restricted, as a consequence of local sharp transitions in climatic traits. The lack of genetic differentiation between these taxa suggests they should be lumped into *G. cuvieri*, while ecological and morphological differences indicate they correspond to distinct ecotypes. Conservation planning of *G. cuvieri* should consider the preservation of both mountain and lowland ecotypes to maintain the overall adaptive potential of the species. This integrative approach provides valuable insights in identifying evolutionary units and should be extended to other gazelles.

Keywords: Bayesian dating analysis – ecological niche-based modelling – *Gazella cuvieri* – *Gazella leptoceros* – geographic information systems – phylogeny – Sahara.

Time allocation and patterns of activity of the dorcas gazelle (*Gazella dorcas*) in a sahelian habitat

Teresa Abáigar & Mar Cano & Conrad Ensenyat

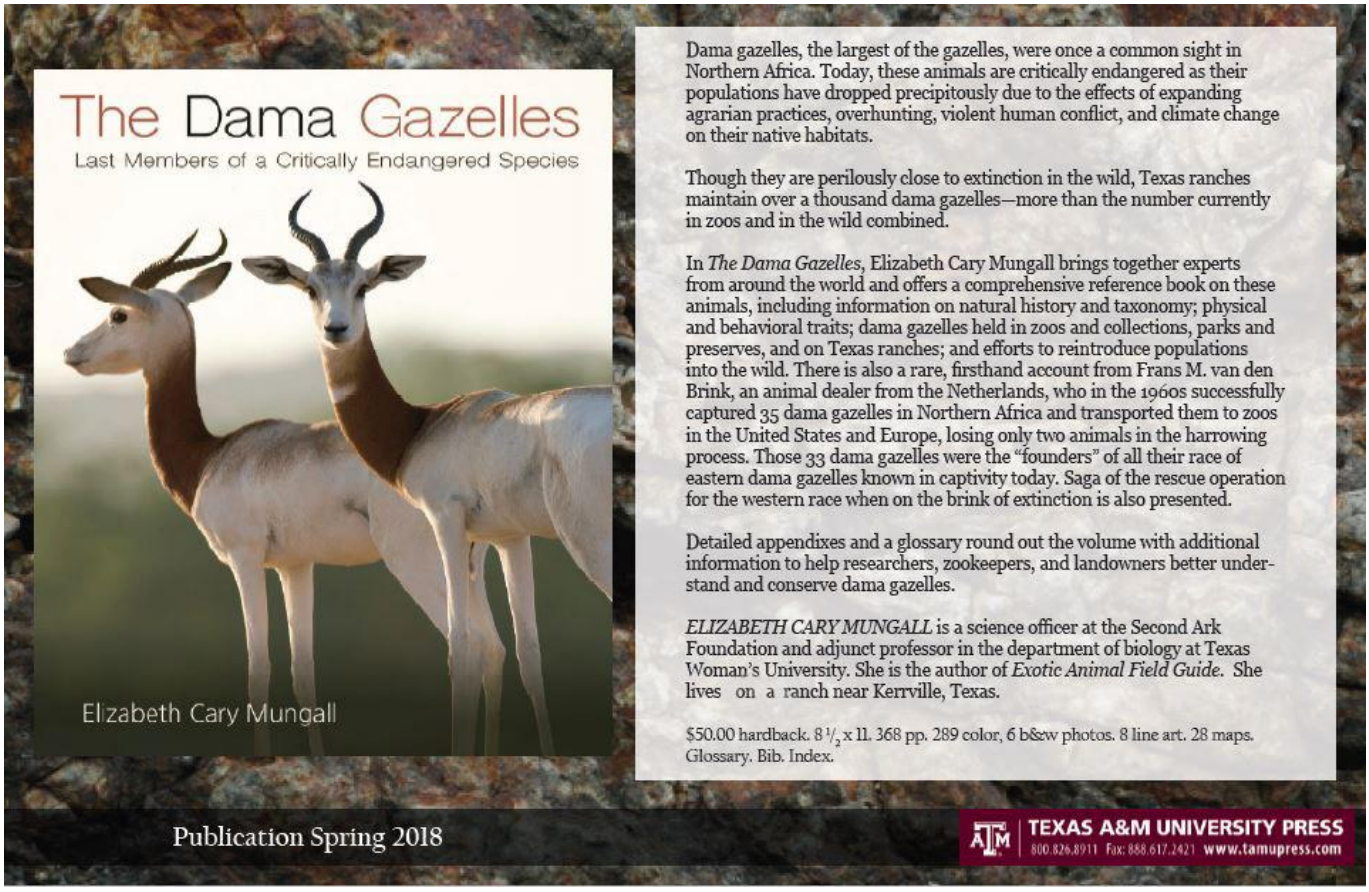
Mammal Research, DOI 10.1007/s13364-07-033.4-0

Abstract

The patterns of activity are a reflection of the adaptation of a species to its habitat. This study reports the patterns of activity and time allocation of the dorcas gazelle following their reintroduction process from the captivity to semi-wild conditions in a sahelian habitat. Activity of three adult males was recorded using GPS collars equipped with a temperature sensor and acceleration sensors recording in two channels, forward–backward (X-axis) and sideways (Y-axis). Collars delivered data for 59, 139 and 151 days. The aim of this work is to assess the ability of dorcas gazelle to adapt its activity schedule to a changing environment. The main activity behavior observed is resting (59.8 ± 23.9%), followed by feeding (20.9 ± 10.9%), displacement (15.1 ± 14.1%) and running (3.9 ± 5.5%). If resting time is eliminated, the gazelles invest most

of their time in feeding (61.0 ± 21.3%) and displacements (30.8 ± 15.6%) and only 7.6 ± 0.6% in running. The dorcas gazelle exhibit three patterns of activity: one diurnal with maximum activity in the central hours of the day, which accounts during the dry-cool season (December, January and February); a bimodal pattern with maximum activity at dust and dark, resting in the middle of the day during the hot-dry season (April) and a transitional pattern in March. Temperature is the main driver of this change in patterns; when average temperature exceeds the body temperature of the dorcas gazelle, the pattern of activity changes from diurnal to bimodal. These results reveal the ability of the Dorcas gazelles facing environmental changing conditions in their native habitat.

Keywords: *Gazella Dorcas*, Time-pattern activity, Temporal niche, Wildlife reintroduction, Sahel



GNUSLETTER

Steve Shurter, Editor
White Oak Conservation Holdings
581705 White Oak Road
Yulee FL 32097

www.whiteoakwildlife.org