

African rhinos and elephants: biodiversity and its preservation

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On the IUCN's website, the preamble to the SSC states that the 'IUCN Species Survival Commission (SSC) is a science-based network of some 7,500 volunteer experts from almost every country of the world, all working together towards achieving the vision of, "A world that values and conserves present levels of biodiversity."' It is thus incumbent upon us, as supporters of this vision, to ascertain what these 'present levels of biodiversity' actually are (SSC, 2011).

As implied in the title of one of the sessions of the UNESCO International Year of Biodiversity Science-Policy Conference, 'The biodiversity knowledge base: Taxonomy today and tomorrow for environmental sustainability and human well-being' (Paris, 25–29 January 2010), the 'basic and indispensable' knowledge base for biodiversity is taxonomy. Although, as in other branches of science, any taxonomic scheme is a work in progress, its practitioners are nonetheless scientists who strive to build their taxonomic arrangements on the maximum amount of data available. Taxonomists are also well aware that the schemes that they construct will be used by conservation planners, as well as by other biological scientists.

For conservation planners, the basic building blocks of taxonomy are species and subspecies. It is essential that we understand what we mean by these categories, so that we are all speaking the same language, and in particular that we are not missing important elements of biodiversity. Both species and subspecies are needlessly in contention among African rhino and elephant conservation biologists.

Until some 20 years ago, the so-called Biological Species Concept (BSC) was what taxonomists usually had in mind when they discussed species. Under this concept, species are held to be 'groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups' (Mayr, 1963). Gradually, during the 1990s, there was a widespread falling away from this concept among taxonomists because of the realization that the BSC has several important limitations:

- a) It does not work with asexual and fossil organisms.
- b) All allopatric forms are *a priori* undervalued: if

two populations, candidates for treatment as either separate species or as subspecies of the same species, are totally separated geographically, how could one ever know whether they are reproductively isolated from one another?

- c) Some species are certainly of hybrid origin (for partial review see Robovský, 2007), and thus could not exist according to the BSC: Père David's deer (Meijaard & Groves, 2004), wisent (Verkaar et al., 2004), North American wolves (*Canis rufus* and *Canis lycaon*) (Kyle et al., 2006), Arunachal macaque (Chakraborty et al., 2007), bat lineage of *Artibeus* spp. (Larsen et al., 2010) and quite a number of colobine monkeys (Roos et al., 2011).
- d) Crucially, we now know that populations of different species often share lineages of mitochondrial DNA, indicating that there has been a history of interbreeding: the classic case is white tailed and mule deer (Bradley et al., 2003).

It is a widely held misunderstanding of the BSC that it stipulates that distinct species *cannot* interbreed. Actually, according to the BSC, species 'do not interbreed under natural conditions': all attempts to test interbreeding under human control (zoos, nature reserves with translocated species from different regions) are not able to give a reliable indication of their species status (as argued extensively, for example, by Mayr (1963) in chapters 5 and 6).

All this has been well discussed in the literature. Plains and Grevy's zebras live sympatrically in some regions and do not interbreed, but when several Grevy's zebras were translocated with a skewed sex ratio (in favour of males) into Ol Pejeta Reserve, they interbred with plains zebras and several viable and fertile foals were born (Cordingley et al., 2009). Lodd et al. (2005) described unexpected crossing between European mink and European polecat caused by a lack of mink females. Brindled and white tailed wildebeest interbreed regularly in South African reserves and private game farms (Ackermann et al., 2010). Hybridization between black and white rhinos occurred in the Game Breeding Centre of the South African National Zoological Gardens (Robinson et al., 2005).

The Phylogenetic Species Concept (PSC), which avoids all these unworkable references to interbreeding, is increasingly widely used by taxonomists. The PSC requires only that species are diagnosably distinct: that is to say, they differ absolutely in one or more heritable characters. The implication is that each species has, in all of its individuals, DNA that does not occur in other, related species. The PSC is the only species concept that is able to work with all scientific evidence (morphological, genetic and behavioural) and based on testable methods.

The PSC has been criticized, especially by some conservationists, on the grounds that quite a few (not all, nor even the majority) of subspecies are 'raised' to species status—hence more, perhaps many more, species are recognised than under the BSC. Brooks states (2010) that, '[t]he problem with this approach [‘PSC’] is that one runs the risk of species-level status being accorded to a large number of subspecies.' It is hard to see why this should be a criticism. If we find that global biodiversity is yet richer than we had imagined, this is surely a cause for celebration, not for criticism. It is something that we must recognize, and learn to live with.

A reclassification of the Perissodactyla and Artiodactyla, employing the PSC, is available in Groves and Grubb (2011). The PSC requires that the Nile rhinos (formerly called the northern white rhino) be recognised as a species, *Ceratotherium cottoni*, distinct from the southern white rhino (*Ceratotherium simum*). This case was extensively considered by Groves et al. (2010), who found that they differ 100% in a number of morphological characters (both craniodental and external) and, though the data are limited, apparently in genetics. It is of great interest, though not germane to the question of species status, that the two white rhino species seem to have been separate for a length of time approaching or perhaps exceeding 1 million years. The observed differences seem to have also striking consequences in their life histories. Throughout their range, southern white rhinos are sympatric with black rhinos; their morphology, presumably including size as well as dentition, enables them to coexist without competing. On the other hand, black and Nile rhinos were nowhere

sympatric; in the east the River Nile formed a border between them—while black rhinos existed in exclusive pockets within the Nile rhino's range—and in the west black rhinos replaced Nile rhinos in the western Central African Republic and northern Cameroon.

The PSC also requires that the forest elephant be recognised as a species *Loxodonta cyclotis* distinct from the savanna elephant (*Loxodonta africana*). The two species are strikingly distinct morphologically, and have fixed genetic differences between them, despite the fact that some populations of savanna elephants possess forest elephant mtDNA, implying that there has been wholesale replacement of forest elephants by savanna elephants in some areas in the not-too-distant past, with interbreeding leading to nuclear swamping (Ishida et al., 2011). As in the case of the two *Ceratotherium* species, it is of great interest, though not crucial for their species status, that the two species of African elephants evidently separated 1.9 million years ago or more (Rohland et al., 2010).

Subspecies lack the operational testability of species: they are geographic populations within a species that differ from one another as a whole, but not 100%. To this degree, it is a matter of some subjectivity: usually it is stated that if 75% of individuals in one geographic region differ from all individuals in another geographic population of the same species (or 90% differ from 90%—statistically equivalent) then it is worth recognizing them as distinct subspecies (see, for example, Groves, 2001). Subspecies in either of the two African elephants species have yet to be worked out, but the black rhino (*Diceros bicornis*) has several subspecies. The AfRSG has deemed it adequate to recognize just four subspecies (Du Toit, 1987), but this has no scientific basis. Based on an unavoidably limited sample (but consisting of what appeared to be all specimens available in museum collections), the recognizable subspecies of black rhinos have been listed by Groves and Grubb (2011). If possible, mixing individuals of different subspecies should be avoided; among other things, the subspecies of black rhino (like those of Asian rhinos) differ in absolute size and in the presence and degree of sexual dimorphism, and this could have implications for differential breeding success in a mixed population.

References

- Bradley, R.D., Bryant, F.C., Bradley, L.C., Haynie, M.L. and Baker, R.J. (2003). 'Implications of hybridisation between white tailed deer and mule deer'. *Southwestern Naturalist* 48:654-660.
- Brooks, M. (2010). 'African Rhino Specialist Group report'. *Pachyderm* 48:8-15.
- Chakraborty, D., Ramakrishnan, U., Panor, J., Mishra, C. and Sinha, A. (2007). 'Phylogenetic relationships and morphometric affinities of the Arunachal macaque *Macaca munzala*, a newly-described primate from Arunachal Pradesh, northeastern India'. *Molecular Phylogenetics and Evolution*, 44(2):838-849.
- Cordingley, J.E., Sundaresan, S.R., Fischhoff, I.R., Shapiro, B., Ruskey, J. and Rubenstein, D.I. (2009). 'Is the endangered Grevy's zebra threatened by hybridization?' *Animal Conservation* 12:505-513.
- Du Toit, R.F., 1987. The existing basis for subspecies classification of black and white rhinos. *Pachyderm*, 9, pp. 3-5.
- Groves, C.P. (2001). *Primate Taxonomy*. Washington: Smithsonian Institution Press.
- Groves, C.P., Fernando, P. and Robovský, J. (2010). 'The Sixth Rhino: A Taxonomic Re-assessment of the Critically Endangered Northern White Rhinoceros'. *PLoS ONE* 5(4), e9703.
- Groves, C.P. and Grubb, P. (2011). *Ungulate Taxonomy*. Baltimore: Johns Hopkins University Press.
- Ishida, Y, Oleksyk, T.K., Georgiadis, N.J., David, V.A., Zhao, K., Stephens, R.M., Kolokotronis, S-O. and Roca, A.L. (2011). 'Reconciling apparent conflicts between mitochondrial and nuclear phylogenies in African elephants'. *PLoS ONE* 6 (6): e20642.
- Kyle, C.J., Johnson, A.R., Patterson, B.R., Wilson, P.J., Shami, K., Grewal, S.K. and White, B.N. (2006). 'Genetic nature of eastern wolves: Past, present and future'. *Conservation Genetics* 7:273-287
- Larsen, P.A, Marchán-Rivadeneira, M.R. and Baker, R.J. (2010). 'Natural hybridization generates mammalian lineage with species characteristics'. *PNAS* 107:11447-11452.
- Lodé, T., Guiral, G. and Peltier, D. (2005). 'European Mink-Polecat Hybridization Events: Hazards from Natural Process?' *Journal of Heredity* 96:89-96.
- Meijaard, E. and Groves, C.P. (2004). 'Morphometrical relationships between South-east Asian deer (Cervidae, tribe Cervini): evolutionary and biogeographic implications'. *Journal of Zoology*, 263:179-196.
- Robinson, T.J., Trifonov, V. and Harley, E.H. (2005). 'Interspecific hybridisation in rhinoceroses: Confirmation of a Black x White rhinoceros hybrid by karyotype, fluorescence *in situ* hybridisation (FISH) and microsatellite analysis'. *Conservation Genetics* 6:141-145.
- Robovský, J. (2007). 'Species that are interspecies crosses – to conserve them or not?' *Gazella (Zoo Praha)* 34:51-64.
- Rohland, N., Reich, D., Mallick, S., Meyer, M., Green, R.E., Georgiadis, N.J., Roca, A. L. and Hofreiter, M. (2010). Genomic DNA sequences from mastodon and woolly mammoth revealed deep speciation of Forest and Savanna elephants. *PLoS Biology* 8 (12): e 10564.
- Rookmaaker, L.C., (1995). 'Subspecies and ecotypes of the black rhinoceros.' *Pachyderm* 20:39-40.
- Rookmaaker, L.C., (2005). 'The black rhino needs a taxonomic revision for sound conservation'. *International Zoo News*, 52 (5):280-282.
- Roos, C. , Zinner, D., Kubatko, L.S. , Schwarz, C. , Yang, M., Meyer, D. , Nash, S.D., Xing, J. , Batzer, M.A. , Brameier, M., Leendertz, F.H., Ziegler, T., Perwitasari-Farajallah, D., Nadler, T., Walter, L. and Osterholz, M. (2011). 'Nuclear versus Mitochondrial DNA: Evidence for Hybridization in Colobine Monkeys'. *BMC Evolutionary Biology*, 11, 77, doi:10.1186/1471-2148-11-77.
- SSC. (2011). Available at: www.iucn.org/about/work/programmes/species/about_ssc/ .
- UNESCO. (2010). Available at: http://www.unesco.org/mab/doc/iyb/Day3_taxonomy.pdf.
- Verkaar, E.L., Nijman, I.J., Beeke, M., Hanekamp, E. and Lenstra, J.A., (2004). Maternal and paternal lineages in cross-breeding bovine species. Has wisent a hybrid origin? *Molecular Biology and Evolution*, 21, pp. 1165-70.