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Feature

Last call to save the rhinos

The family Rhinocerotidae with many species spread around the world was a distinct feature of the global Pleistocene fauna, but most of these species are now extinct. Three of the five surviving species are critically endangered, due to habitat loss and a surge in criminal hunting for horns. To save these iconic species, conservation science will have to apply all methods at its disposal, from population management through to advanced genomics and forensics. **Michael Gross** reports.

Rhinoceroses roamed all over the European steppe as recently as 20,000 years ago. The range of the woolly rhino (*Coelodonta antiquitatis*) extended from Siberia across what is now the North Sea into England. Apart from fossil remains, a rib bone used for a late Palaeolithic carving was found in a limestone gorge in northern England, and the famous rock art in the Chauvet Cave in southern France displays no fewer than 65 depictions of rhinos, presumed to be of the woolly kind. Other caves and stone-age artefacts also bear witness to the fact that rhinos once were a familiar sight to ancient Europeans.

As the climate changed and human hunters improved their weapons, the woolly rhinoceros disappeared around 12,000 years ago, along with much of the Pleistocene megafauna, of which only the marine part survives with its species richness almost intact (Curr. Biol. (2015) *25*, R209–R212). Like other families of terrestrial megafauna, rhinoceroses vanished everywhere except in parts of Africa and South Asia.

The closest extant relative of the woolly rhino is the Sumatran rhinoceros (*Dicerorhinus sumatrensis*), which is now critically endangered with fewer than 100 animals surviving in the wild. The Javan rhinoceros (*Rhinoceros sondaicus*) and Africa's black rhinoceros (*Diceros bicornis*) share this undesirable Red List status, while the Indian rhino (greater one-horned rhinoceros; *Rhinoceros unicornis*) is listed as vulnerable and the white rhino (*Ceratotherium simum*) is only 'near threatened', although its subspecies, the northern white rhino is extinct in the wild.

Next to habitat loss, the illegal hunting fuelled by the demand for its horn is the biggest concern. Although there is no scientific evidence for any medical benefit, and it is chemically identical to clipped fingernails, the horn is still valued as a supposed medicine in Asia. Much like elephants (Curr. Biol. (2016) *26*, R865–R868) and sharks (Curr. Biol. (2014) *24*, R341–R344), rhinos are suffering from the rapidly growing purchasing power of Asian customers. On a smaller scale, additional demand for rhino horn also comes from Yemen, where ceremonial daggers with handles carved from the horn are prized as a symbol of status and masculinity.

Within the time of *Homo sapiens*' spread around the world, the family of rhinoceroses moved in the opposite direction, from a globally represented success model to a dwindling group of exotic species. Conservation science faces a tough battle trying not to lose any of the five surviving species.

Managing populations

Africa today hosts two rhino species, which are confusingly called black and white rhinoceros, although they are not distinguishable by colour. The 'white' one (*Ceratotherium simum*), which is also the largest surviving extant rhino and thus one of the largest terrestrial mammals, possibly owes its name to its wide mouth, and the more narrow-mouthed 'black' one (*Diceros bicornis*) was simply assigned the opposite attribute to highlight its difference.

Both species only survive in very limited ranges, mostly in national parks. Both have faced extinction risk in the past but are now recovering in numbers. Of the white rhinoceros, the northern subspecies is extinct in the wild, and attempts to breed offspring from the three individuals surviving in captivity are proving challenging.

The southern white rhino, mainly present in South Africa and neighbouring countries, has been brought back from the brink. There were fewer than 100 of the animals in 1895. Stringent protection of the animals within South Africa's national parks has enabled the population to recover and grow exponentially, doubling every decade, such that recent estimates suggest there are now more than 20,000 individuals.

The black rhino is further behind with its recovery. Its most difficult period was between 1970 and 1992, when

Hairy beast: The critically endangered Sumatran rhinoceros is considered the closest living relative of the woolly rhino, which roamed across Europe in the Stone Age. (Photo: Michelle Curley.)

Little helper: Rhinoceroses often struggle with parasites colonising their skin, which in turn attract birds. The image shows an Indian rhinoceros at the Cincinnati Zoo. (Photo: Tom Uhlman.)

it was hunted almost to extinction. After a slow recovery, it is still critically endangered with around 5,000 animals in the wild.

In an attempt to extend its range and grow its population, African Parks, based in Johannesburg, South Africa, in collaboration with the Rwanda Development Board have recently translocated a founder population of 20 eastern black rhinos from South Africa to the Akagera National Park in Rwanda, 10 years after the species was last seen in this country.

African Parks has taken on the management of the park in 2010 and since then has focused on stamping out poaching and on reintroducing species that have been wiped out there. Special provisions have been put in place to protect the new rhino population from any poachers that might try their luck.

Meanwhile, some of Asia's rhinos are also moving to new homes. Nepal's Chitwan National Park, which boasts a growing population of Indian rhinos (*Rhinoceros unicornis*) has repeatedly served as a source to repopulate other nature reserves where rhinos have become sparse, including Bardiya National Park and Shuklaphanta National Park. In recent years, the park has mostly been able to keep poachers at bay. In April 2017, it suffered its first rhino casualty in three years, while security forces were busy in the run-up to local elections.

Elsewhere, the narrow range of the critically endangered Javan rhino (*Rhinoceros sondaicus*) may make it particularly vulnerable to extinction, conservation researchers have warned. The last remaining population of some 60 animals lives in Ujung Kulon National Park, near Mount Krakatoa, Indonesia, an area at considerable risk of earthquakes and tsunamis.

In a recent study, Brian Gerber from Colorado State University at Fort Collins, USA, and colleagues used extensive camera traps to monitor the population (Conserv. Lett. (2017) https://doi.org/10.1111/conl.12366) and found that 62 individuals were alive in 2013, which marks a very slight recovery from a low point of only 25 animals in 1937.

Analysing the distribution and movements of the population, the researchers found that around 80% of the territory currently used by this last population of the species could become devastated in a ten-metre tsunami, which in that area is likely to occur within the next 100 years.

The authors therefore suggest that a translocation project should be set up urgently, to establish a new population on safer ground. This might also facilitate further population growth, as it is estimated that the habitat in Ujung Kulon National Park has reached its carrying capacity. Moreover, the risk inherent in a translocation event will in this case be outweighed by the risk inherent in the current situation, the authors argue.

Prosecuting poachers

In the presence of the growing demand for the horn, and the market mechanisms that mean scarcity will only drive up prices and thus profit margins for poachers, scientific methods and creativity are equally needed to stop the slaughter of the rare animals.

There have been various attempts to stain the horns of wild rhinos to make them traceable and less attractive to poachers. In a research paper published in this issue, Cindy Harper from the University of Pretoria, South Africa, and colleagues take the tracing approach to the level of genetic fingerprinting (Curr. Biol. (2018) *28*, R13–R14). The authors report genotype and population analyses of white and black rhinoceroses, enabling forensic scientists to link confiscated horn products to specific poaching incidents and thus to elucidate trade connections and achieve more forceful sentences for those caught.

In a recent court case in Malawi, three men convicted of poaching a black rhinoceros in Liwonde National Park were sentenced to 18, 10, and 8 years of prison. A rhino carcass had been discovered in the park on July 13, 2017, and the horns were found the same day using tracking technology. This has been the first such sentence since Malawi strengthened its wildlife laws in December 2016.

However, there are limits to what law enforcement can achieve when it faces strong consumer demand — as the failure of the global war on drugs has demonstrated for more than a century now (Curr. Biol. (2013) *23*, R585–R588). Some alternative approaches are based on attempting to undermine the market value of the rhino products. Conceivably, flooding the market with synthetically made, bio-identical materials indistinguishable for the buyers could bring the soaring prices back down to the level where poaching is no longer seen as lucrative.

In a detailed analysis of the economics of fake rhino horns, Frederick Chen from Wake Forest

University at Winston-Salem, North Carolina, USA, comes to the conclusion that the most useful approach might be to drive down the quality of the product as well as the price (Ecol. Econ. (2017) *141*, 180–189).

"This proposal makes use of a phenomenon in economics known as adverse selection, which occurs when buyers in a market are unable to distinguish between high- and low-quality products. This lack of information can drive down prices enough that high-quality products, which in this case would be real rhino horns, would cease to be supplied by sellers," Chen explained in a press statement.

As this race to the bottom would naturally be unattractive for businesses producing the fake product, Chen suggests that governments or conservation groups should provide incentives for the production of the rhino-saving substitutes.

Next generation: The southern subspecies of the white rhino has been a conservation success story after narrowly escaping extinction at the end of the 19th century. (Photo: Cindy Harper.)

Escaping the bottleneck

Given the precarious state of all but the southern white rhinoceros — which itself has survived a recent population bottleneck — genomic studies are necessary to establish the viability of the critically small populations and to guide any efforts to improve their prospects by breeding and population management.

Mike Bruford from Cardiff University, UK, and colleagues have recently reported a comprehensive analysis of genetic markers in the black rhino. Using tissue and fecal samples of wild animals as well as skin from museum specimens, they were able to obtain genetic profiles of both the surviving populations and those that became extinct within the last 200 years (Sci. Rep. (2017) *7*, 41417).

The researchers found that the species lost 69% of its mitochondrial genetic diversity in the last two centuries, as many genetic lineages that characterised separate populations in the 18th century have become extinct. On the other hand, the authors discovered that the West African subspecies *Diceros bicornis longipes*, which was declared extinct in 2011, survives as a few individuals in the Masai Mara.

This detailed mapping of the surviving populations offers the opportunity to rethink conservation efforts, the authors conclude. "We also identify conservation units that will help maintain evolutionary potential. Our results suggest a complete re-evaluation of current conservation management paradigms for the black rhinoceros," the authors write. The researchers aim to sequence the full genome of the species next, in order to establish how the genetic bottleneck might affect it. The genome of the white rhinoceros was published in 2012.

In a research paper in this issue, Herman Mays from Marshall University at Huntington, West Virginia, USA, and colleagues present the genome of the critically endangered Sumatran rhinoceros (*Dicerorhinus sumatrensis*), enabling insights into the population history of the species as well as its current genetic bottleneck (Curr. Biol. (2018) https://doi.org/10.1016/j.cub.2017.11.021). While the results suggest a troubled past even in the Pleistocene, after which anthropogenic pressures pushed the species closer to the edge of extinction, it will be challenging to derive a strategy to bring it back from the brink.

Some rhino saviours never give up, however. Although only three individuals of the northern white rhino survive, Tate Tunstall at the San Diego Zoo Institute for Conservation Research and colleagues recently reported that the 'Frozen Zoo' collection at the institute holds genetic diversity similar to that of living rhino populations and would thus be sufficient to bring the species back.

Beyond the somewhat romantic view of rhinos and other big beasts as ambassadors from a bygone geological epoch, there are good ecological reasons to try to save what is left of the Pleistocene megafauna and maybe even bring some of it back. For instance, recent research has shown that large animals contribute disproportionately to the redistribution of nutrients against the flow of the hydrological cycle, and that much of this global nutrient pump has already been destroyed by human activities (Curr. Biol. (2016) *26*, R1–R5).

While the three critically endangered species are facing a tough battle for survival and the northern white may be a lost cause, the southern subspecies demonstrates that rhino populations can recover after severe bottleneck situations. Thus, there is still hope for the other four species. Conservation science will have to use all the tricks of its trade to ensure that these rare survivors of the Pleistocene megafauna stay with us in the future.

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