Archaeologist lends a technique to rhino protectors

Tool could be used to track illegally obtained horn

Over the past 50 million years, rhinocerotoids have been "the most ecologically diverse and successful group of large herbivores" on the planet, according to paleontologist Donald Prothero of Occidental College in Los Angeles. Rhinoceros relatives have ranged in size from collie dog–sized creatures to great dinosaurian beasts the equal of five bull elephants. Since hominids gained their current dominance, however, the five remaining rhino species—Indian, Javan, and Sumatran in Asia and black and white rhinos in Africa—have not fared well (*BioScience* 38: 740–744). Millions were estimated to have lived at the turn of the century. Only 11,000 survive today.

The rhino's greatest liability is its horn. In China, it has been long valued as a staple in folk medicines. In Yemen, it is carved into expensive dagger handles. Trade in rhino horn has been banned by international treaty for more than a decade, but the ban has done little to stem the animal's slaughter. A rhino sporting ten pounds of horn worth at least $20,000 in Taiwan is a tempting target for hunters in the earth's poorest regions. Most surviving rhino populations are small, heavily managed, and dependent on government-hired armed guards to save them from poachers.

Zimbabwe, South Africa, and Namibia harbor almost three-fourths of the world's rhinos. Although poaching remains a serious problem in parts of the region, these southern African populations overall are stable or expanding.

Increasingly, these southern African nations are looking for ways to recoup the huge expense of managing their rhinos successfully. All three countries have accumulated massive stockpiles of horn from natural deaths in their herds and confiscations from poachers. In South Africa alone, the horn cache is growing at the rate of $1 million a year. Now those nations want to sell this horn to pay for the upkeep of the rhinos.

Is there a way to open a highly controlled legal trade in horn that will help the rhino pay for its own conservation? Some proponents of controlled trade say the first step toward meeting this controversial goal is to have in place a foolproof method for identifying the geographic origin of any piece of horn brought to market. At a meeting in May sponsored by the San Diego Zoological Society, archaeologist Nikolaas van de Merwe told 300 rhino experts from around the world that he has succeeded in creating such a method.

Red flag goes up

Van de Merwe's announcement raised an immediate red flag among staunch opponents of the horn trade. It presages a controversy next March when the member nations of the Convention on International Trade in Endangered Species (CITES) meet in Japan.

Zimbabwe, Namibia, and South Africa are expected to ask the gathering to consider modifying the ban on selling rhino horn. All five rhino species are listed on CITES Appendix I, the list of animals whose products cannot be traded internationally. The southern African nations would like to see their populations downlisted to Appendix II. Products from animals listed in Appendix II can be traded through a regulated permit system.

If the animals were downlisted, the three governments would have to set up a system to control horn sales. The stocks would come from animals that die naturally, materials confiscated from poachers, or horns knocked off in fights or trimmed off by gamekeepers. (Since 1989, game wardens in Namibia have been trimming horns from living rhinos to foil poachers.)

What van de Merwe, a professor both at Harvard University and the University of Cape Town in his native South Africa, has developed is an isotopic analysis that he says can resolve the origin of a rhino horn back to the game park where the rhino lived. The method is a spinoff of his archaeological work: using mass spectrometry to analyze fossil bones for clues about ancient diet and environmental conditions. He made a debut in the world of endangered-species controversies in August 1990 by describing in *Nature* (346: 744–746) an isotopic test for tracing the geographic origin of elephant ivory.

Tracking rhino horn origins

Van de Merwe's foray into rhino tracking began last January. "At the time, police in Cape Town had just arrested somebody with more than 100 rhino horns that he was about to ship to Taiwan," van de Merwe says. "It's easy enough to prosecute that person. But it is awfully difficult to follow the trail back and find out where the horn came from and how it got to him."

So Anthony Hall-Martin, director of special services for the National Parks of South Africa, asked van de Merwe for help. Could he tell which

by Yvonne Baskin

Southern white rhino. Photo: Zoological Society of San Diego.

species of African rhino, black or white, the horn came from? And could he tell from which park?

Because the two species have different diets, van de Merwe says the first question proved easy to resolve using carbon isotopes alone. Black rhinos browse on twigs and leaves; whites graze on grasses. Trees and grasses in the African subtropics have each evolved to use a slightly different photosynthetic process for assembling carbon molecules from the carbon dioxide they absorb from the air.

Atmospheric carbon dioxide, the photosynthetic starting material for all plants, contains 1% carbon-13 isotopes and 99% carbon-12. Because carbon-13 is the heavier isotope, it participates in chemical reactions at a slower rate than carbon-12. Thus every chemical reaction lowers the ratio of carbon-13 to carbon-12. Also, all trees and shrubs in the regions inhabited by African rhinos make a three-carbon sugar in the first photosynthetic step, whereas all grasses make a four-carbon sugar. (In contrast, grasses and trees in tropical rainforests and temperate woodlands make three-carbon molecules in the first photosynthetic step.) More chemical reactions are involved in making a three-carbon sugar, so trees and shrubs have lower ratios of carbon-13 to carbon-12 in their tissues. African rhinos that eat those trees and shrubs also have lower ratios of carbon-13 to carbon-12 in their tissues than do rhinos that eat grasses.

By running a horn sample the size of a fingernail paring through a gas mass spectrometer, van de Merwe can quickly distinguish black from white rhinos by their distinctive carbon-isotope signatures. Pinpointing the precise game park of origin proved slightly more difficult. For that, van de Merwe added isotopes of three other elements to the analysis—nitrogen, strontium, and lead.

The annual rainfall in a region is reflected in the ratio of nitrogen-15 to nitrogen-14. The more arid the region, the higher the nitrogen-15 levels in its plants and its herbivores. The heavy isotopes of strontium and lead, which must be measured with a different mass spectrometer, reflect the age of the parent rock in a region. Younger rock in East Africa's volcanically active Rift Valley, for instance, has a mix of strontium isotopes distinct from that of the ancient desert surface of Namibia. These elements erode from rock, leach from soil into groundwater, and are taken up by plants and animals in the area.

For the majority of African rhino horn samples, a computerized statistical analysis of carbon, nitrogen, and strontium isotopes is enough to pinpoint their origins. Lead isotopes can be used to resolve any questions that remain, van de Merwe says.

Trick horn identified

By May, van de Merwe had tested almost 100 horn samples taken from rhinos that were captured for translocation or that had died of natural causes. In one case, game park authorities slipped in two samples of horn from the same black rhino bull—one from the tip and another from the base.

Van de Merwe's analyses traced the samples to two separate parks. But it was no mistake. The bull had been translocated from a wet region to a park in a drier area years before, so each sample reflected a distinct diet and climate.

Van de Merwe is now seeking horn samples from other parts of Africa and Asia to determine the unique isotopic signatures of those regions. The rainforests of Asia, he says, should be easy because of their recycling of carbon.

The rainforest canopy is so dense that the air trapped below it is inhibited from mixing with the atmosphere above. Thus most plants growing below the canopy (those low enough to be food for browsers and grazers) use carbon dioxide released from rotting biomass on the forest floor. All these below-canopy plants make three-carbon sugars, so the available carbon is further depleted of carbon-13 isotopes every time it is recycled through a plant.

Horn analysis is costly

The archaeologist believes his method is ready to be used in the courtroom. But details of how it could be used to test and mark rhino horn for sale in a tightly controlled market remain for others to work out. The isotopic analyses themselves are not cheap. David Killick, van de Merwe's lab manager at Harvard, says tests of carbon and nitrogen isotopes cost approximately $50 each, and the equipment exists in 500 to 600 government, industry, and university labs around the world. Analyses of heavy isotopes are more expensive, approximately $250 each, and only 30 to 40 places in the world—mostly geology or geophysics labs—have the appropriate mass spectrometers.

The costs of testing, however, are minor compared to the price of horn. "The bottom line is that the horn carried by two rhinos can buy the land and the fences and the armed guards to save one other rhino," says van de Merwe.

However, van de Merwe says his single greatest reservation in advocating a reopening of a legal market is the possibility that it would spark a greater demand for Asian rhino horn, which sells for ten times the price of African horn. Asian rhinos have smaller horns, which, in the folk medicine trade, are commonly believed to have more concentrated healing properties for lowering fevers or curing nosebleeds. The powdered horn is believed to make a more powerful drug, making it more costly. Also, surviving Asian rhino populations are smaller than most African ones, and they are threatened as much by habitat destruction from logging and human settlement as by hunters.

At the May meeting, the strongest advocate of a legal horn trade was assistant director Rowan Martin of Zimbabwe's Department of National Parks and Wildlife Management. He cautioned the gathering that the costs of providing armed guards and land to save rhinos is perceived in his country as "a bottomless pit with little economic return." Money provided by the world conservation community has been small relative to that provided by the southern African nations themselves.

"It's fine to say rhinos belong to the world and they must be saved, but the world isn't paying the cost," Martin says. "We are."

But Kenya-based geographer Esmond Bradley Martin, who has spent more than a decade tracking the horn trade and working to stifle demand, declared that there will not be any modifications in CITES' designations without a fight.

Ulysses Seal, chairman of the captive breeding group of the International Union for the Conservation of Nature (IUCN), believes a legal market for rhino horn will not be easy to institute in the near future, although, he says, it is a legitimate long-term goal.

"The IUCN has taken as a base for its conservation policies the sustainable utilization of wildlife," Seal notes. "Problems like this have to be solved if that's going to be a legitimate foundation for conservation."□

Yvonne Baskin is a freelance science writer based in San Diego, California.