The Standing Rock Sioux Reservation runs a field course for budding palaeontologists in the tribe.

G. GRELLET-TINNER

School of rock

Native Americans want to claim fossil resources found on their lands. **Rex Dalton** looks at how tribes and palaeontologists are working together to avoid bitter ownership disputes.

In the heart of America's dinosaur country, the relationship between Native Americans and outside palaeontologists has always been tense. In the 1890s, the battle between white settlers and Native Americans was barely over when legendary fossil-hunter Edward Cope arrived to prospect for bones in the grassy hills that make up the Standing Rock Sioux Reservation in North and South Dakota. A century later an amateur palaeontologist digging in the neighbouring Cheyenne River reservation unearthed the largest and best-preserved *Tyrannosaurus rex* known, setting off an epic legal battle involving the research institute she worked for, the Sioux rancher who owned the land on which the fossil was found, and local tribes.

But that long-standing tension was nowhere to be seen this July. On the Thunder Hawk Ranch on the Standing Rock reservation, near the sacred grounds where Chief Sitting Bull was born and died, Native American students came together for what is believed to be the nation's first palaeontological field school conducted by a tribe. Led by Swiss-born palaeontologist Gerald Grellet-Tinner, the students worked just as Cope did a century ago, unearthing fossils under a punishing sun broken only by torrential rain.

If this field school is any indication, Native Americans could be on the verge of instituting sweeping changes that will resonate throughout the palaeontological community. Some tribal members, such as those who ran the dig site this summer, want to focus on the history and fossil resources of their land. Others, though, are seeking ways to protect their palaeontological heritage more aggressively.

Two decades ago, Native Americans pressed for new laws covering ancient human remains. The resulting legislation, the 1990 Native American Graves Protection and Repatriation Act (NAGPRA), transformed US archaeology. NAGPRA required that any remains be returned to the custody of tribes who could prove they had a 'cultural affiliation' with them. Thousands of items have since been repatriated, prompting archaeologists to complain that their museum collections are being depleted of specimens for scientific study.

Land rights

Now, some tribes are looking to extend that concept to fossils. Next week, a committee in the Nebraska legislature will hold a hearing about whether new legislation is needed to protect palaeontological resources on tribal lands. Nebraska's decision is important because the state contains large expanses of reservation land — and as such it often pioneers laws that involve Native Americans. For instance, it enacted a law protecting Native American human remains even before the federal NAGPRA was passed.

The Nebraska drive was spurred by Lawrence Bradley, a doctoral student in geography at the University of Nebraska in Lincoln, who was raised by the Lakota people. Bradley openly acknowledges that he would like to see

the repatriation of fossils taken by major East Coast museums a century ago[1].

Others are simply trying to improve the often-rocky relationships of today. In Standing Rock, for instance, the Dakota/Lakota people are now seeking the return of specimens taken from tribal lands by fossil hunters (see 'Fossil fray'). And in New Mexico, leaders of the Pueblo of Jemez community charge that a scientist from a state museum tricked them into getting access to the reservation, but didn't train a Native American student as they expected in return.

In 2004, tribe member Kevin Madalena agreed to help Spencer Lucas, both at the New Mexico Museum of Natural History and Science in Albuquerque, get access to the Jemez reservation to collect geological samples. But Madalena says that Lucas gave him very little instruction, cutting him out of the possibility of co-authoring the resulting article[2]. Lucas, who has been criticized before for the way he deals with students[3], says that he is surprised to hear of the criticism.

But for the young Madalena, the real lost opportunity was for his tribe and its resources. "It is imperative to educate native communities and non-natives about the importance of guarding palaeontological resources," he says.

At Standing Rock, they are working on that bond. Last year, the governing tribal council approved a 24-page Paleontological Resource Code, which set out provisions for a palaeontology office, defines agency responsibilities, created permitting requirements, and affirmed tribal ownership rights of specimens. The tribe is thought to be the first in the United States and Canada to adopt such a code, authorities say.

The strict rules have taken a while to be taken up by the reservation, which encompasses nearly a million hectares on the west side of the Missouri River. For years, the tribe tried to curb looting by tightly controlling access to the reservation; tribal members were also told to stop picking up any fossils they might find.

But in 2004, Gale Bishop, then director of the geology museum at the South Dakota School of Mines and Technology in Rapid City, helped the US Bureau of Indian Affairs and the tribe to collaborate with his museum and the Indian Affairs bureau to assess and develop the palaeontological resources. After Bishop retired in 2006, however, the university and the tribe began to differ over how to complete the survey.

Then Grellet-Tinner arrived. The lanky

outdoorsman came from Switzerland by way of Texas, Los Angeles and Brazil. Trained as a gemologist, he later turned to palaeontology and explored rich fossil beds in China and Argentina. By the time he got to South Dakota's School of Mines and Technology, his experience of working with different cultures helped him smooth over the troubles between the tribe and the university. Grellet-Tinner straightened out the paperwork and contracted with the tribe to help develop its palaeontology programme.

"The tribe has a tremendous opportunity here — fantastic palaeontological resources, eager students and the financial support of its leaders," he says. The Standing Rock council spent US$50,000 to run the field school this summer, including a second week-long session for half-a-dozen tourists.

> **"The tribe has fantastic palaeontological resources, eager students and the financial support of its leaders."**
> — Gerald Grellet-Tinner

Tribal council member Henry Harrison credits Grellet-Tinner with turning the palaeontology programme around. The Standing Rock tribe now runs the programme from its headquarters in Fort Yates, North Dakota. The 6,000-member tribe is also building a fossil-preparation laboratory at its Sitting Bull College and hopes to build a palaeontological museum to bring not only tourists and economic development, but also scientists to study specimens found on the reservation.

The land contains a wealth of material. The field site is on a working cattle ranch, which is located a 30-kilometre drive down gravel roads from the main highway. Rocks here expose both the Hell Creek Formation — one of the most famous sedimentary beds for dinosaur fossils, dated at just over 65 million years old — and the slightly older Fox Hills Formation, at 68 million years old. Both sites record how the great Cretaceous seaway that once divided North America was receding at the time. "What is now Montana was exposed before the Dakotas," says Grellet-Tinner. "When Montana was a delta, the Dakotas were under water. When Montana was a plain, the Dakotas were becoming a delta."

With each rainstorm and snow melt, fossils erode out by the hundreds. "I found sites that were literally bone beds, with so many fossils you couldn't walk on the ground without stepping on fragments," says Bishop, who is now at Georgia Southern University in Stateboro. "There are several world-class deposits on that reservation."

Bone bounty

This July, students recovered and casted about 40 substantial specimens, which are now at the lab at Sitting Bull College. They include a possible new crocodilian species, along with sea shells that act as markers of the climatic conditions as the great seaway was receding. "I think this material will lead to some quality publications," says Grellett-Tinner.

To the budding scientists, the chance of contributing to a scientific article was more than they dreamed of in their camping tents. "I never imagined it would be like this; it was awesome," says Vida Dogskin, a Dakota/Lakota from Sitting Bull College. A single parent with four children, Dogskin is an environmental-science major now following an interest in dinosaurs. "I


R. DALTON

Gerald Grellet-Tinner has turned around relations between academics and the Standing Rock tribe.

Fossil fray

A South Dakota tribe and a Minnesota college are clashing over the rights to some important palaeontological specimens.

Five years ago, government officials and tribal leaders in South Dakota discovered that excavations on private land had extended onto a tribe-owned ranch. In all, fossil hunters had collected several thousand specimens, including a suite of duck-billed dinosaurs, or *Edmontosaurus*, ranging from juveniles to adults. And now the Native Americans want the fossils back from Concordia College, the institution in Moorhead, Minnesota, that helped collect many of them.

"We want them to do the Christian thing and return the fossils," says Steven Emery, counsel for the Standing Rock Sioux Reservation.

But for years Concordia's president, Pamela Jolicoeur, has refused all requests from the tribe to return the bones. Only now, on enquiries from *Nature*, has an attorney for the college, Bruce Quick, suggested that the tribe might get the fossils back. "If they continue to want them returned," he says, "they can have them."

The dispute began in June 2003, when officials at the US Bureau of Indian Affairs found Ronald Nellermoe, a biologist at Concordia, and his students excavating in a bone bed overlooking the Grand River. The officials discovered that a tractor digging on private land owned by the Schmidt family had extended excavations onto the Thunder Hawk Ranch owned by the Standing Rock tribe. They ordered that all digging be stopped, and it hasn't resumed since.

Nellermoe's dig ran alongside another one conducted by Adventure Safaris of Santa Maria, California, which sells excavation opportunities as a 'mobile creation-science camp'. Nellermoe, who says he is not a creationist, is also a past board member of the Grand River Museum, a creationist facility built by the Schmidts in the nearby town of Lemmon, South Dakota.

Tribal members suspect that some fossils displayed in the museum came from the reservation. Nellermoe denies that this is the case. The tribe has no proof, and hence has focused its demands on bones at Concordia, he says.

The tribe has repeatedly asked the US attorney's office for South Dakota to investigate and prosecute offenders. The officials refused.

In a letter to tribal council chairman Ron His Horse Is Thunder in August 2006, Jolicoeur admits that a loader was used to dig on reservation land. And Nellermoe acknowledges that an undetermined number of fossils had been unearthed from tribal land. He says he knows which fossils are from which site and they could "probably" separate out the reservation specimens. But "we never felt we had to do that," he adds.

Nellermoe has since given some of the *Edmontosaurus* specimens to other scientists for isotopic analysis[5], but his group has otherwise published little beyond some geological background[6].

R. DALTON

The Grand River Museum pitches fossils as examples of extinction rather than evolution.

Today at the Grand River Museum, a wall mural shows dinosaurs romping alongside bison. Staff at the creationist museum say that the dinosaur fossils on display are there to illuminate "extinction", not "evolution". According to them, dinosaurs just didn't make it onto Noah's ark in time. And so they display a model of the ark right next to the dinosaur fossils. **R.D.**

jumped in to learn as much as I can," she says. Dogskin picked up the trade so quickly that she was hired as a technician apprentice to help store and inventory the summer's finds.

For Matthew Wood, a member of the Seminole tribe originally from Oklahoma, the field school was a chance to fulfil a lifelong desire to study dinosaurs. A junior information-science major at Sitting Bull College, he is now looking at a career in palaeontology or a related field. "I thought I might learn a little, but I learned much more than I expected," says Wood. "It was all hands-on — an incredible experience."

The summer's finds are already heading for analysis elsewhere. Grellet-Tinner plans to send ammonite fossil samples from the Fox Hills Formation to the University of Claude Bernard Lyon I in France. Researchers there are preparing the specimens to be analysed in a mass spectrometer to measure their ratio of oxygen-16 to oxygen-18, which can indicate the temperature and depth of the water in which they formed. Grellet-Tinner says the team will also be analysing dinosaur bones — in part to try to determine whether dinosaurs were warm- or cold-blooded, which is still under debate[4].

Will students who participated in the field-school research be included in the article? "Of course," he says. And one day this may be the model for a new era of paleontological research on tribal lands — in which Native Americans collaborate with outside experts and share in the scientific analysis and credit. If so, it will be a long way from the days of the wars over bones on the Great Plains. ■

Rex Dalton is a reporter for *Nature*, based in San Diego.

1. Dalton, R. *Nature* **449,** 952–953 (2007).
2. Lucas, S. G., Krainer, K., Colpitts, R. M. *New Mexico Mus. Nat. Hist. Sci. Bull.* **31,** 101–117 (2005).
3. Dalton, R. *Nature* **451,** 510 (2008).
4. Amiot, R. *et al. Earth Planet. Sci. Lett.* **246,** 41–54 (2006).
5. Thomas, K. J. S. & Carlson, S. J. *Palaeogeogr. Palaeoclim. Palaeoecol.* **206,** 257–287 (2004).
6. Colson, M. C., Colson, R. O. & Nellermoe, R. *Rocky Mountain Geol.* **39,** 93–111 (2004).