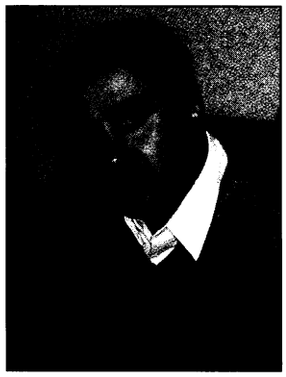
All along, say staffers and outsiders, the Centro Atómico was isolated from much of Argentina's political and economic turmoil. While the military government of the 1970s—the same government that "disappeared" thousands of Argentines and fought and lost the Falklands war—devastated the universities, for example, the Centro Atómico went relatively unscathed. One buffer was simply its distance from the capital. "They are out in the sticks," says superconductivity researcher David Bishop of AT&T Bell Laboratories, "and that really saved them." Another was CNEA's own privileged status. "We were lucky," says Caro, "because both military and democratic governments found different reasons to support atomic energy—as you can imagine." As a result, says Carlos Balseiro, a solid-state theorist who heads the academic programs at the Centro Atómico, "we had stability for 40 years."



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Planning for survival. Centro Atómico director Alfredo Caro.

But now the world has changed for CNEA—and for the Centro Atómico. Roberto Ornstein, CNEA's director of international relations, explains that Menem's government has already dismantled much of the Peronist legacy of state-run companies, privatizing everything from the state oil company to telephones and transportation, "and now it's time for atomic energy too." To sustain his institute's applied research programs through the transition, Caro is consciously trying to imitate the survival strategy of U.S. national laboratories by stressing the commercial promise of the materials, processes, and software developed in the Centro Atómico's laboratories.

Around the Centro Atómico, researchers list the contract work now under way: developing metal-matrix composites for components in racing-car engines, designing heat-resistant magnetic cores for electromagnetic pipe welding, and writing software that schedules the unloading of tankers at an oil terminal. The contracts topped $1 million last year, says Caro, but he acknowledges that meeting his goal of covering 30% of the Centro Atómico's annual budget—or about $5 million—through such arrangements will be difficult. "We don't have any experience in marketing," he says. Another hurdle may be what many Argentine scientists describe as their country's technological inferiority complex—a tendency to doubt that anything good could be invented at home.

The prospects for the basic research that was the Centro Atómico's original mission and still accounts for most of its international reputation are even more uncertain. The pace of research and publication has not slackened, but there's a background of gloom and gallows humor. No one can forget that from now on, the Centro Atómico's isolation and prestige will offer little protection when ill winds blow from Buenos Aires.

–Tim Appenzeller

ARGENTINA

Patagonian Dinosaurs Reveal A Cosmopolitan Cretaceous

NEUQUÉN, ARGENTINA—For 100 kilometers around this dusty provincial city in northern Patagonia, the arid uplands are broken by fossil-bearing outcrops of red and yellow rock. These striking formations are windows into a time 110 million to 75 million years ago, during the final chapter in the reign of the dinosaurs. And to a trio of young paleontologists, the rocks are offering up surprise after surprise. Their discoveries—half a dozen new dinosaurs over the past 5 years—are transforming the image of the dinosaurs that inhabited South America at a time when continental drift was carrying that landmass into ever greater isolation. "With each new specimen we have to redraw the picture," says one member of the group, Leonardo Salgado of the University of Comahue in Neuquén.

Five years ago Salgado and his colleagues Jorge Calvo in Neuquén and Rodolfo Coria, based 100 kilometers away in the small town of Plaza Huincul, expected that their work would add to the established picture of a unique fauna. Earlier discoveries, many of them by José Bonaparte of the Museum of Natural History in Buenos Aires and his students—among them Salgado, Calvo, and Coria—implied that during the Cretaceous period, from about 145 million to 65 million years ago, South America and perhaps other southern continents evolved an assemblage of dinosaurs sharply different from those of North America and Eurasia. But the newer bone strikes are blurring that north-south divide, and the mid- to late-Cretaceous scene in South America is looking increasingly cosmopolitan. "In the last 5 years, we've started to find representatives of [northern] dinosaur lineages never recorded in South America," says Coria.

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Dino-finders from Patagonia. From left to right, Rodolfo Coria, Leonardo Salgado, and Jorge Calvo.

Paleontologists elsewhere are watching with interest. "They've got a burgeoning fauna there," says Johns Hopkins University paleontologist David Weishampel, who adds that he will be eager to learn more about "who these creatures are and what their relations are." One reason for the interest, explains the University of Chicago's Paul Sereno, is that the fate of the dinosaurs in the Cretaceous is a test of how the migrations of continents affect patterns of evolution: "There's been no experiment quite like this in the history of life."

The beginnings of the experiment go back to the Jurassic period, which ended about 145 million years ago, when most continents were united in a single supercontinent called Pangaea. Dinosaurs roamed freely across the supercontinent, and the major dinosaur lineages were found throughout the world. By the end of the Jurassic, however, the supercontinent was rupturing into a northern part called Laurasia and a southern part called Gondwana. At that point, many paleontologists believe, the dinosaurs on each landmass began to go their own way. By the middle and late Cretaceous, when Gondwana and Laurasia in turn were breaking up, few reminders of their former kinship were left—or so it seemed until recently.

On the northern continents of Laurasia, the giant vegetarian sauropods of the Triassic and Jurassic periods—creatures like *Brachiosaurus* and *Diplodocus*—had died out and been replaced as plant-eaters by the ornithischians, a varied group that included the duck-billed hadrosaurs and the armored

Triceratops and *Ankylosaurus*. But in South America, Africa, and the rest of Gondwana, the sauropods remained dominant, in a lineage known as the titanosaurids. Titanosaurids, recognized in Argentina a century ago, were long-necked creatures that had ball-and-socket joints between their tail vertebrae—an adaptation that may have stabilized the tail when they reared up on it, some paleontologists speculate.

The meat-eaters also seemed to follow separate paths. On the northern continents so-called tetanurans—a group of bipedal predators that included *Tyrannosaurus rex*—were the main scourge of the vegetarians. In South America and perhaps other southern continents, that role fell to a different set of carnivores known as the abelisaurids. Among them was an outlandish creature called *Carnotaurus*, with twiglike forearms and a pair of horns on its brow, which Bonaparte and his colleagues excavated in Patagonia in 1984.

These distinctions did break down at the very end of the Cretaceous, a time when a titanosaur turned up in the southwestern United States and a hadrosaur resembling a North American form appeared in Patagonia. But Bonaparte and others have assumed that migration between North and South America was responsible for these parallels. At the end of the Cretaceous, geologic evidence suggests that a land bridge emerged between the two landmasses. After being separated for millions of years, their fauna could finally mix.

Enter the paleontologists from Neuquén, and that picture of north-south dichotomy begins to fray at the edges. One new form, which Calvo excavated about 80 kilometers from the town, rests in dozens of pieces in a back room of the university's small paleontology museum. Although the creature—a sauropod—dates from the mid-Cretaceous, before the land bridge opened, Calvo thinks it's a type of beast known from the Jurassic of North America: a diplodocid, a whip-tailed, small-headed creature with nostrils on the top of its head.

Elsewhere in the museum is another form that may not fit the earlier picture: a delicate bipedal ornithischian that must have been no more than a meter high as an adult—this one, even smaller, is a juvenile—called *Gasparinisaura*. When Salgado found *Gasparinisaura* 2 years ago, recalls Coria, "we thought it was an immigrant from Laurasia. Why not—it was from the top of the Cretaceous," when the hypothetical land bridge was supposed to have joined North and South America. But Coria has been studying the creature's anatomical details, and the closer he looks, the less it resembles northern forms. Now he is inclined to say that the creature's forebears may have been in Gondwana all through the Cretaceous. The north-south similarities, he thinks, are the results of convergent evolution.

PHOTOS BY T. APPENZELLER

Prospector's delight. Fossil-rich Cretaceous strata near the town of Plaza Huincul in Patagonia. These rocks are largely unexplored.

Coria and Salgado think the same could also be true of the hadrosaur from the late Cretaceous, which Bonaparte and others had originally suspected of being an immigrant. "Not all ornithischians in South America have to be the result of a North American migration," says Coria.

Rounding out the challenge to the north-south dichotomy during the Cretaceous is a new carnivore excavated 60 kilometers from Neuquén. This creature may be big enough to dethrone *T. rex* as the largest meat-eater ever to walk the earth (*Science*, 16 December 1994, p. 1805), but size isn't its only distinction. Coria and Salgado's early study of the specimen, which they reported last October at a meeting of the Society for Vertebrate Paleontology in Seattle, has convinced them that it doesn't belong with the abelisaurids, the group that includes *Carnotaurus* and other South American carnivores from the Cretaceous. Instead, they think it's a tetanuran—part of the same general lineage as *T. rex*.

These interpretations are only now being submitted for publication, but already they're sparking some controversy. Bonaparte, for example, doubts that Calvo's sauropod is a diplodocid, and he thinks the duck-billed hadrosaur is so close to North American forms that it has to be an immigrant. The same goes for *Gasparinisaura*, adds Johns Hopkins' Weishampel: "I'd be hard-pressed to have that critter be anything but an immigrant." Sereno, however, tends to agree with Coria that *Gasparinisaura* was indigenous but sides with Bonaparte about the hadrosaur.

But Bonaparte and Sereno both agree that the trio in Neuquén have found some forms that don't fit neatly into the picture of a north-south divide. To Bonaparte the "northern" forms are anomalies—relics of Jurassic groups that, after the breakup of Pangaea, left a few survivors in Gondwana while they flourished in Laurasia. Sereno has a more radical explanation: Based on his own findings in Africa, he has argued that the northern and southern landmasses remained linked well into the Cretaceous—too late for their dinosaur assemblages to have diverged dramatically by the late Cretaceous (*Science*, 14 October 1994, pp. 219 and 267). The South American discoveries, he thinks, support this idea.

At this point, says Dale Russell of the Canadian Museum of Nature in Ottawa, "either [interpretation] might be right. ... My counsel is caution." Coria and his colleagues are happy to follow that advice. Salgado thinks "it's too early to come up with paleobiogeographical hypotheses" about how ancient geography affected the patterns of life. He, Coria, and Calvo have their hands full just sorting through the evidence they have already dug up—and searching the Patagonian hills for more. "We have much material," says Coria, "and we are very few."

–Tim Appenzeller

Pieces in a puzzle. The paleontology hall at the Museum of Natural History in Buenos Aires is crowded with specimens from Patagonia, among them *Amargasaurus*, an early-Cretaceous sauropod with dramatic neck spines *(left)*.