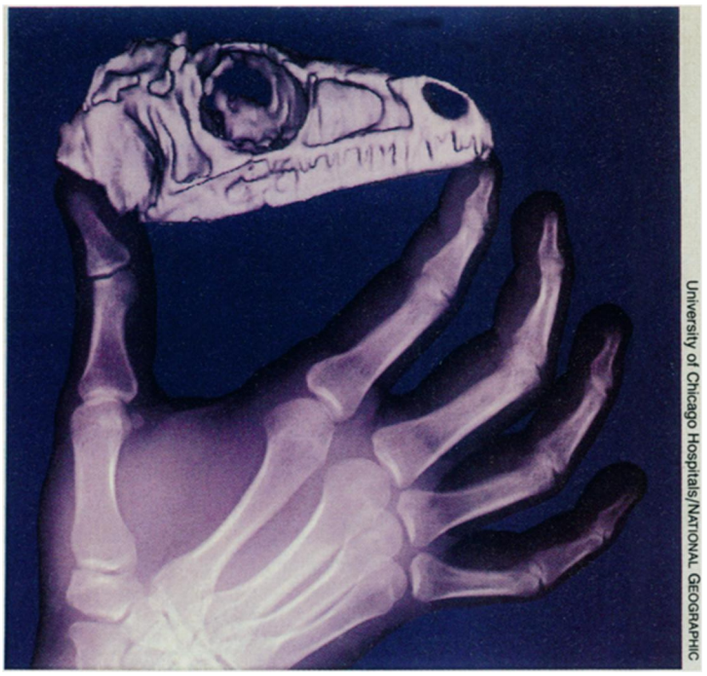
The Accidental Reign

By RICHARD MONASTERSKY



Composite X-ray image shows the size of Eoraptor's *skull relative to Paul Sereno's hand. Features of the specimen indicate that this animal was an adult.*

Argentina has twice blessed Paul Sereno.

In 1988, the young University of Chicago paleontologist traveled to the beautiful Valley of the Moon in the foothills of the Andes and returned with the best-preserved fossil ever found of *Herrerasaurus,* the oldest and most primitive dinosaur then known. Sereno revisited the same sculpted badlands in 1991 and came home with a new type of dinosaur even more basic in its anatomy than *Herrerasaurus.* Naming the creature *Eoraptor,* Sereno unveiled the specimen earlier this month at a press conference and in the Jan. 7 NATURE.

Because it is the most primitive dinosaur ever found, *Eoraptor* provides an unprecedented look backward into the earliest evolution of these beasts from an ancestral form that spawned all later dinosaurs. "When we look at the skeleton of *Eoraptor,* we have perhaps our best chance to test out theories about dinosaur origins," Sereno says.

Along with *Herrerasaurus,* the new find is also offering insight into how dinosaurs rose from humble beginnings to reign over the continents for a staggering 150 million years. The emerging picture suggests that rather than wresting control of the Earth from the dominant beasts of the time, dinosaurs may have reached the top simply through blind luck.

The *Eoraptor* and *Herrerasaurus* skeletons found by Sereno and his colleagues come from the Ischigualasto Provincial Park in northwestern Argentina. Set against a backdrop of imposing red cliffs, the Valley of the Moon in Ischigualasto contains a lunar landscape of rare rocks laid down during the late Triassic period, roughly 230 million years ago, when dinosaurs first appeared on Earth.

As dinosaurs go, *Eoraptor* was tiny, reaching only a meter long. The dog-size creature walked upright and had a mouthful of curved, serrated teeth — the signature of a carnivorous life-style.

According to Sereno, *Eoraptor's* skull was particularly primitive, displaying almost none of the specialized adaptations that characterize the three main dinosaur subgroups: the meat-eating theropods, which include *Tyrannosaurus;* the gargantuan sauropods, which include brontosaurus; and the herbivorous ornithischians, which include *Triceratops.*

"The skull for all intents and purposes is ancestral. For the most part, it is nearly identical to what we would have expected the ancestral dinosaur to look like," says Sereno.

Even *Herrerasaurus,* a contemporary of the 225-million-year-old *Eoraptor,* seems specialized in comparison. While the new species had a simple jaw, *Herrerasaurus* and later theropods had a sliding jaw joint that helped in subduing live prey, according to Sereno and Fernando E. Novas of the Argentine Museum of Natural Sciences in Buenos Aires. They described the new *Herrerasaurus* specimen in the Nov. 13, 1992 SCIENCE.

Other parts of the *Eoraptor* anatomy also come close to that of the ancestral dinosaur, although the new fossil does show some specialization. *Eoraptor's* hand had three fingers well designed for gripping and slashing open prey — a characteristic that links it with theropods, according to Sereno.

Did a lucky break allow the dinosaurs to take over the Earth?

During the dinosaurs' heyday, long after *Eoraptor* had vanished from Earth, the ornithischians, sauropods, and theropods each evolved specialized bodies suited to their modes of life. Because the various groups had such dissimilar anatomies, early dinosaur investigators presumed that the bird-hipped ornithischians had evolved from a different stock of reptiles than had the sauropods and theropods, which together form a group called saurischian dinosaurs, characterized by their lizard-like pelvises.

In 1974, paleontologists Robert T. Bakker and Peter M. Galton challenged the established view by suggesting that all dinosaurs evolved from a single common

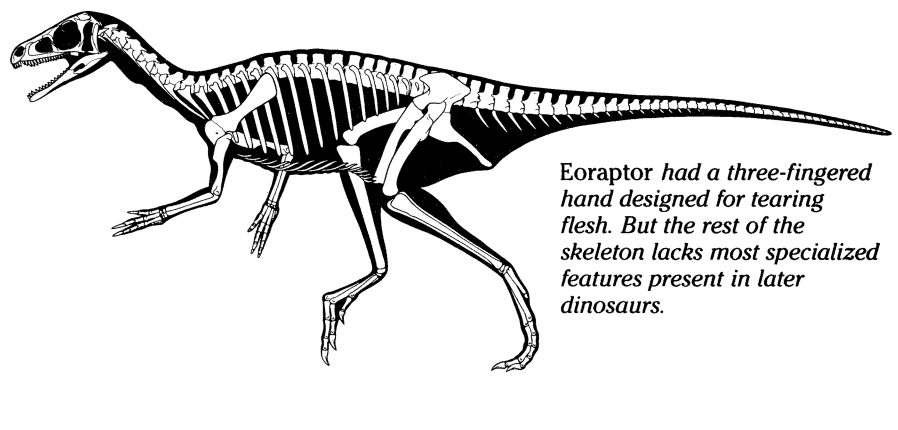
ancestor. The two researchers showed that some saurischians and ornithischians had remarkably similar joints, indicating that the earliest members of these two lineages had sprung from one line of animals that bore features common to both groups.

To visualize that ancestral dinosaur, many paleontologists have looked to a small reptile called *Lagosuchus,* which lived in the Ischigualasto region in the mid-Triassic period, 10 million years before *Eoraptor.* While not a dinosaur, *Lagosuchus* had evolved some features similar to those of the later beasts. It had a hinged ankle joint that helped it walk erect with its legs underneath its body, as did the dinosaurs. Other animals at the time walked with their legs out to the sides of their bodies, in a more sprawling, crocodile-like posture.

While many paleontologists consider *Lagosuchus* a dinosaur precursor, it can't provide a true picture of the ancestral dinosaur because it lacked many critical innovations that characterize all dinosaurs. "We could really only draw a common stem [ancestral] form of dinosaurs on paper. There wasn't any fossil that even approximated it," says Hans-Dieter Sues of the Royal Ontario Museum in Toronto. "This new find is really a tremendous discovery because we didn't have any idea what the common stem form of dinosaurs really looked like."

According to Sereno, the primitive nature of the *Eoraptor* skull supports the theory that dinosaurs arose from a common ancestor and only later developed specializations that would split them into ornithischians and saurischians. The new discovery also confirms earlier suspicions about what the ancestral dinosaur looked like.

On the basis of *Herrerasaurus* and other finds, researchers have pictured the earliest dinosaurs as small, bipedal carnivores—a description that matches *Eoraptor.* This dinosaur itself could not have been the common ancestor because it had already evolved specializations that place it within the theropod subgroup. But the *Eoraptor* skeleton is as close to a common ancestor as researchers may ever find, Sereno says.



Carol Abraczinskas and Paul Sereno

Eoraptor *had a three-fingered hand designed for tearing flesh. But the rest of the skeleton lacks most specialized features present in later dinosaurs.*

Even paleontologists prepared for finding small dinosaurs might have been surprised by the tiny size of *Eoraptor,* says Sues. Many of the other reptiles living in Ischigualasto at that time would have far outweighed the early dinosaur, which must have survived by preying on still smaller creatures or by taking the young of large animals, Sereno says. The name *Eoraptor,* or "dawn stealer," reflects that presumed life-style.

From months of prospecting in the region, Sereno knows that dinosaur skeletons are among the rarest fossils in Ischigualasto's rocks dating from the time of *Eoraptor.* This indicates that *Eoraptor* and the other dinosaurs alive at the time played a relatively small role in the ecology of the region. It was a world dominated by crocodile-like animals, lizards, and ancient relatives of the mammals.

Travel forward 10 million years, however, and the rocks from Ischigualasto record a different picture, one of a world in which many of the once dominant reptiles have disappeared and dinosaurs rank as the most abundant fossils.

Paleontologists have long wondered how dinosaurs rose to the top of the ecosystem – a position they would hold from the late Triassic, roughly 215 million years ago, until the end of the Cretaceous, 65 million years ago, when they disappeared and mammals inherited dominion over the world. The traditional explanation, one in keeping with the classical Darwinian theme of natural selection, holds that dinosaurs established their supremacy through competition with their contemporaries. By dint of some advantage – perhaps their agile posture or their faster metabolism – dinosaurs proved more successful than the existing creatures, which were eventually driven to extinction.

To test the competition theory, Sereno has tabulated the numbers of dinosaurs and their contemporaries living in Ischigualasto through time. If the dinosaurs had driven other reptiles out through competition, the numbers should show ornithischian dinosaurs becoming more common and other herbivorous reptiles less common. Similarly, theropod dinosaurs should have replaced the carnivorous reptiles of the time.

"In fact, we don't see that pattern in this one site. That pattern simply is not manifested," says Sereno.

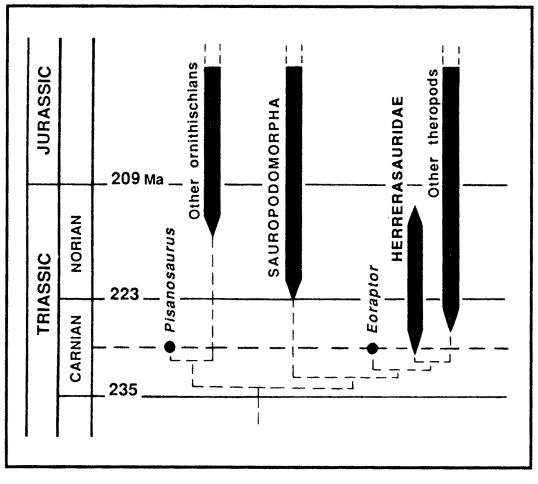
The recent finds in Ischigualasto support an alternative view, that dinosaurs took control more by luck than anything else, Sereno says. This idea was first proposed a decade ago by paleontologist Michael J. Benton of the University of Bristol in England.

The *Eoraptor* and *Herrerasaurus* skeletons show that dinosaurs had developed many specialized anatomical features early, long before the reptiles became common. By the time of *Eoraptor,* during the mid-Carnian stage of the Triassic period, dinosaurs had already split into the major groups of carnivorous theropods and herbivorous ornithischians.

"Dinosaurs are rare, and yet they are differentiating. They look like they were waiting in the wings and it was only later that they became the most common," Sereno says.

The dinosaurs may owe their success to something accidental, a major extinction that killed off most of the other animals but allowed the dinosaurs to live on unaffected, says Sereno. That extinction could have stemmed from any number of causes—from a meteorite impact to a severe climate change, he says.

Some scientists have reported finding evidence of mass extinctions and impacts at the end of the Triassic (SN: 2/8/92, p.91). Indeed, two geologists reported last year that the large Manicuoagan crater in eastern Canada formed



Sereno

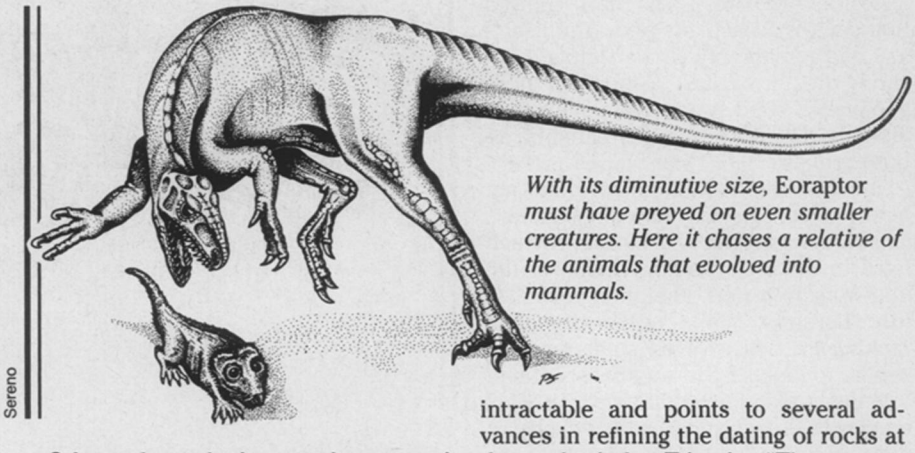
Paleontologists believe Eoraptor *lived shortly after the dinosaurs arose and split into the separate lines of ornithischians, sauropods, and theropods.*

soon after the time *Eoraptor* lived. But it remains unclear whether these impacts and mass extinctions occurred at the same time that dinosaurs became common, says Sereno.

If dinosaurs did get a lucky break in the beginning, that would bring their story full circle, for it was an accident that brought about their downfall. The dinosaurs died out at the end of the Cretaceous, a time when many scientists believe a meteorite or comet hit Earth. That crash apparently wiped out the last of the dinosaurs, although most species had already started to dwindle before the great impact, perhaps because of severe climate changes in much of their habitat, some paleontologists suggest.

Whatever the cause of the dinosaurs' extinction, it rid the world of the largest land animals, creating the opportunity for mammals to take over. Mammals had evolved in the late Triassic, at roughly the same time as the dinosaurs, but the mammals remained tiny and inconsequential until the dinosaurs disappeared, Sereno says.

Sereno cautions that he has tested the competition hypothesis only in Ischigualasto, which represents just one small part of the supercontinent that existed in the late Triassic period. Researchers must look closely at sites of similar age around the world to see if the same pattern shows up.



Sereno

With its diminutive size, Eoraptor *must have preyed on even smaller creatures. Here it chases a relative of the animals that evolved into mammals.*

Other paleontologists say the cause of the dinosaurs' rise is a difficult problem and probably has a more complex solution, one that may involve competition, changing environmental conditions, and other factors. Kevin Padian of the University of California, Berkeley, comments that "the late Triassic is a very busy time. There are lots of other animals around. The dinosaurs are entering a very crowded world."

Both he and Sues say it is difficult to weigh the validity of the various theories raised to explain the dinosaurs' success. "I don't think any of the existing ideas are really testable at this point," Sues remarks.

Benton does not regard the problem as intractable and points to several advances in refining the dating of rocks at the end of the Triassic. "The greater refinement of stratigraphy and new discoveries like Sereno's are giving us a closer and tighter view of what was going on," he says.

Sereno acknowledges the difficulty in tracing the dinosaurs' rise, but he believes the population data for Ischigualasto argue against the competition theory. He plans to publish his findings later this year.

"The neat thing is that the picture seems to be emerging that the dinosaurs were taking their turn," Sereno says. "They got a lucky break and they stayed in for 150 million years, and then something happened and mammals have been in for 65." □