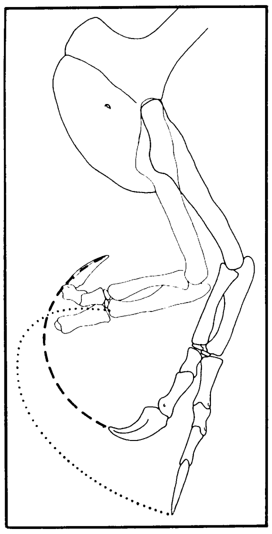
Paleontology

Ron Cowen reports from College Park, Md., at the Fourth International Congress on Systematic and Evolutionary Biology

Strong-arming the *T. rex* forelimb

It had long, powerful hindlimbs to chase after enemies, teeth that cut like steak knives, and muscle-bound jaws that could hold struggling animals in a death grip. But *Tyrannosaurus rex,* the largest of the carnivorous dinosaurs, also had 3-foot-long forelimbs that seemed downright diminutive compared with the rest of its 40-foot-long body.

Paleontologists long assumed that the small size signified floppy, feeble forelimbs that served no critical function. But two researchers, armed with a comprehensive study of the most complete *T. rex* skeleton ever unearthed, have gone out on a limb with a new theory. These front appendages packed enormous power, capable of holding some 426 pounds of prey, they assert. Moreover, they say, the two claws attached to each forelimb faced in opposite directions and could dig into an animal like grappling hooks, immobilizing the creature until *T. rex's* razor-sharp teeth finished the kill.


Carpenter

Side view of T. rex *forelimb shows movement of the two claws.*

"People had been looking at [forelimb] function based on proportionate size. I don't think that's appropriate," says Matt B. Smith, a research assistant at Montana State University's Museum of the Rockies in Bozeman. Rather than follow traditional thinking, Smith and paleontologist Kenneth Carpenter of the Denver Museum of Natural History took a new tack, examining the capacity of a *T. rex* forelimb to bear weight without comparing the limb to other body parts of the giant dinosaur.

From studies of a nearly intact *Albertasaurus* skeleton, Smith calculated that the forelimbs of this large dinosaur – with a body build similar to *T. rex* – could hold more weight than previously thought. Two years ago, the arrival of a rare *T. rex* forelimb from a paleontological site near Bozeman prompted him to extend his studies. He and Carpenter measured the width of the fossil's "scar" – the spot where a tendon would attach the biceps muscle in the living dinosaur. They inferred that the biceps muscle was huge – about the diameter of an entire human thigh – and capable of bearing a stationary force of about 426 pounds, more than any other dinosaur biceps and roughly 10 times more than a human biceps. The finding prompted Carpenter to dub *T. rex* "the Schwarzenegger of dinosaurs."

As excavators at the site uncovered and identified additional pieces of the *T. rex* skeleton, Smith and Carpenter found themselves examining finger bones as well as the carpal and metacarpal bones that make up the forelimb. Using wax to hold the bone joints together, they discovered the forelimb's two claws have an unusual feature. Unlike the human thumb and forefinger, which meet like pincers to grasp objects, the two dinosaur claws face away from each other like the barbs of a fishing hook, each embedding separately in the doomed animal's flesh.

Smith says some researchers remain doubtful that *T. rex* used its forelimbs to capture prey. Skeptics reason that the forelimbs – however mighty – were still woefully short and would have required the dinosaur to either lower its chest on top of an animal or hug the prey to its chest in preparation for killing it. Instead, some suggest, *T. rex* may have used its forelimbs to pick up dead animals from the ground.

Space Sciences

Saturn: Ring ripple suggests 19th moon

Clues to an unseen moon have hidden since 1980 in the spiky, weed-like patterns of brightness recorded by Voyager 1 as it flew past Saturn's F-ring. By mathematically parting those weeds, astronomers have found five gentle ripples of ring brightness, each with its own periodicity. One ripple, they say, suggests that an unidentified moon, less than 10 kilometers in diameter, traces an eccentric orbit around the giant planet.

Scientists have long puzzled over irregular density variations in Saturn's F-ring, and have suspected that the gravity of nearby moons plays a role. To explore that possibility, Robert A. Kolvoord and Joseph R. Burns of Cornell University, working with Mark Showalter of Stanford University, indirectly examined the density variations by analyzing the ring's shine. Clumping and spreading of F-ring particles, they reasoned, would increase and decrease the ring's reflectivity.

As expected, the analysis showed one undulation due to Prometheus, the nearest satellite to the ring at a distance of 832 km. However, the smaller and more distant moon called Pandora – 1,520 km from the ring – causes no apparent perturbation, they report in the June 21 NATURE.

One of the four remaining ripples hints at the gravitational influence of an elusive moon located 1,180 km from the ring, the researchers say. But a final ruling on the proposed moon – which would represent the planet's 19th known satellite – must await the scrutiny of the Cassini orbiter, scheduled to begin its tour of Saturn in 2002.

Mars magnetism: A moot question?

Many space probes have landed on, orbited or flown past Mars, but none has clearly shown whether the planet produces its own magnetic field. A definitive answer may depend on an orbiting spacecraft called the Mars Observer, scheduled for launch in 1992. However, two NASA scientists now conclude that even if Mars does have an intrinsic magnetic field, it is "not of any consequence."

In other words, the magnetic field would be too weak to keep the solar wind from reaching Mars' upper atmosphere, or ionosphere, assert Kushal K. Mahajan and Hans G. Mayr of NASA's Goddard Space Flight Center in Greenbelt, Md.

The pressure of the solar wind varies. Thus the wind pushes with more or less force against a planet's ionosphere, altering the layer's height and density – unless the planet has a magnetic field strong enough to deflect it.

The Mariner 9 orbiter examined Mars' ionosphere in 1971 and 1972, as did the pair of Viking orbiters that circled the planet in 1976. Although none of these orbiters flew through the ionosphere, their radio beams pierced it at times when their radio signals grazed Mars on the way to Earth.

In the ionosphere, extreme ultraviolet (EUV) light from the sun changes neutral atoms into electrically charged ions and free electrons. The more intense the EUV, the more ionization occurs. The Viking mission reached Mars when the sun was near the minimum in its 11-year activity cycle and showing relatively small EUV changes, whereas Mariner 9 orbited near a solar maximum, when the sun's EUV brightness was more variable.

Yet a new analysis of their Mars-grazing radio beams indicates the ionosphere was being disturbed on both occasions, Mahajan and Mayr report in the June 1 JOURNAL OF GEOPHYSICAL RESEARCH. This, they say, could result from variations in the pressure of the solar wind, and thus offers little if any sign that a magnetic field keeps the solar wind at bay.

Even a modest magnetic field would probably hold off much of the wind, the authors say. The radio signals show that the Martian ionosphere can be disturbed by the solar wind's pressure changes at any time in the solar cycle, they maintain.