

report coauthor Robert W. Greene of Harvard Medical School's Brockton (Mass.) Veterans Administration Medical Center.

This observation is central to a proposal put forth by H. Craig Heller of Stanford University and Joel H. Benington of St. Bonaventure University in Olean, N.Y. A few years ago, the pair pondered the mystery of why animals need to sleep. A host of theories, ranging from memory consolidation to aiding the immune system, have addressed this provocative issue.

Heller and Benington suggested that sleep occurs when some or all of an animal's brain becomes dangerously low on energy. Since the sleeping brain is much less active than the waking one, sleep allows the organ to replenish its energy, they proposed.

Adenosine could fit into this theory nicely, says Benington. Since adenosine secretion reflects brain cell activity, rising concentrations of this chemical may be how the organ gauges that it has been burning up its energy reserves and needs to shut down for a while.

To understand how adenosine induces sleep, Greene's team has studied the compound's effect on the brain's arousal centers. Cells in these centers have con-

nections throughout the brain, and they help keep a body awake and alert. Test-tube studies of the cells conducted several years ago showed that adenosine "can actually shut them off," says Greene.

From that work, Greene's group hypothesized that increasing concentrations of adenosine near arousal centers might compel an organism to sleep.

In the new study, the scientists anesthetized cats and implanted electrodes in several regions of the brain, including arousal centers, to monitor neuronal activity. They also inserted small probes to sample the extracellular fluid.

The researchers found that adenosine concentrations near an arousal center were higher when the cats were awake than when they were asleep.

The scientists then deprived the cats of sleep by constantly playing with them. After 6 hours or so of playing, the felines were exhausted. "At the end of the sleep-deprivation period, they just sit there and look at you trying to get their attention," says Tarja Porkka-Heiskanen, a study coauthor.

At that point, adenosine concentrations in the cats' brains were, on average, double those observed when the

cats had been awake for 2 hours. During 3 hours of "recovery" sleep, adenosine concentrations fell slowly.

Adenosine "is likely not the only sleep factor that exists in the brain. There may be others," notes Greene, adding that adenosine concentrations that normally induce sleep may be overcome sometimes by an excited or stressed animal.

Greene expects his group's work will stimulate renewed interest in adenosine, but he cautions against expecting a new sleeping pill soon. Even though the brain chemical induces a natural sleep that many current sleeping pills cannot duplicate, medicinal adenosine exerts several other effects. It can lower body temperature, alter blood pressure, and damage the heart.

The recognition of adenosine's importance in inducing sleep is gratifying, given that many scientists once discounted the connection, says Radulovacki.

The 64-year-old scientist notes that a friend recently asked him if he were happy that adenosine is now a hot topic. "I feel a lot better than when they ignored me. A scientist has to live long to reap the benefits," Radulovacki laughingly responded.

—J. Travis

## T. rex bested by Argentinean beast

For generations of North American children, *Tyrannosaurus rex* has reigned as the most fearsome and favorite dinosaur, a tyrant unparalleled by carnivores on any other continent. Recent discoveries in Argentina have dethroned *T. rex* and raised up a new contender for the title of King Carnivore.

In Philadelphia last week, an audience of children gasped as paleontologists unveiled a 6-foot-long model skull showing *Giganotosaurus carolinii*, a dinosaur that surpassed *T. rex* in size.

Rodolfo A. Coria and his colleagues at the Carmen Funes Museum in Plaza Huincul, Argentina, first uncovered bones of *Giganotosaurus* in 1993 and estimated the dinosaur's length as 41 feet (SN: 9/23/95, p. 199). Last year, the researchers discovered many more bones of the skull, enabling them to reconstruct the animal's head more accurately. Coria now calculates that

*Giganotosaurus* reached 45 to 47 feet long and weighed 8 to 10 tons—making it 10 percent longer and a full 3 tons heavier than *T. rex*, says Coria.

"It is really very humbling, as a North American, to stand in front of this beast," says Peter Dodson of the University of Pennsylvania in Philadelphia.

There are even larger *Giganotosaurus* specimens waiting to be discovered, says Coria, who has found pieces of a second that is bigger than the original.

Another challenger for the King Carnivore title is an African theropod called *Carcharodontosaurus* (SN: 5/25/96, p. 335). Coria estimates that *Giganotosaurus* was larger than this African giant, which was a close relative.

Paul C. Sereno, a paleontologist at the University of Chicago who discovered a new specimen of *Carcharodontosaurus* in Morocco in 1995, debates that point. Sereno contends that it is difficult to tell the size range of a species from just a few specimens. Moreover, there are not enough whole bones from the skull of *Giganotosaurus* to estimate even that specimen's length precisely.

All the paleontologists agree, however, that it is far more important to understand the animals' evolutionary history and their ecological roles



Reconstruction of *Giganotosaurus* skull. Human skull indicates relative size.

than to settle the size contest. Dodson notes that although these giant carnivores were similar in size, "the menu for each animal was very, very different."

*T. rex*, which lived 65 million years ago at the end of the Cretaceous period, fed on herbivores that were roughly its size or smaller. The 97-million-year-old *Giganotosaurus* dieted on herbivorous sauropods nearly twice its size.

*T. rex*'s reputation endured further humiliation this week when researchers reported that the dinosaur suffered occasionally from gout. Bruce M. Rothschild of the Arthritis Center of Northeast Ohio in Youngstown and his team discovered sphere-shaped pits—telltale signs of the disease—in the hand bones of several *T. rex* specimens, they report in the May 22 *NATURE*. Gout is extremely painful and infrequently afflicts modern reptiles and birds, says Rothschild.

"Caricatures of the agony and ill temper of those afflicted with gout are magnified by its recognition in *T. rex*," the group notes.

—R. Monastersky



Artist's depiction of two *Giganotosaurus* on the prowl.