PERSPECTIVES

RESEARCH, SCHOLARSHIP, AND CREATIVE ACTIVITY AT OHIO UNIVERSITY

Reflections on the Past

A modern look at dinosaurs

AUTUMN ▲ WINTER 2001
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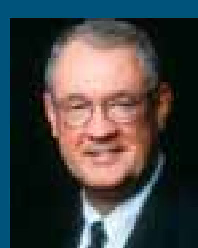
Prelude

AS A NEW ACADEMIC YEAR STARTS this fall, so begins another chapter in Ohio University's research endeavor. In fiscal year 2001, the university's external funding for research and other sponsored programs rose by 9.75 percent to an all-time high of $53.9 million. The largest increase in funding came in the area of research awards, which jumped 20.4 percent in the past year to $24.5 million. Ohio University faculty, staff, and students engaged in research, scholarship, and creative activities attracted an increase of support from local, state, federal, private, and industry sources. We're proud of these figures — they represent a research and scholarly program that is growing stronger and more vibrant each year. ▲ The articles in this issue of *Perspectives* magazine offer a sampling of some of those efforts. Our cover story spotlights a paleontologist who is reconstructing the facial features of dinosaurs, information that can help us understand how these prehistoric beasts lived. The work captured widespread interest earlier this year with findings published in the journal *Science*. Other articles feature a theater designer's quest to uncover the tricks and trades of the Hollywood costume industry, new research on chronic tension headache pain, and a documentary photographer's work to capture a vanishing generation of African-American seniors in an Ohio steel town. In this issue, we also examine how Ohio University has joined the ranks of many higher education institutions across the nation in commercializing faculty research for the marketplace. ▲ In addition to the reports on these pages, we invite you to explore Ohio University through the online edition of *Perspectives*, available on the Web at *www.ohiou.edu/perspectives*. We hope you enjoy this issue of *Perspectives*, and as always, we appreciate your comments.



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PERSPECTIVES

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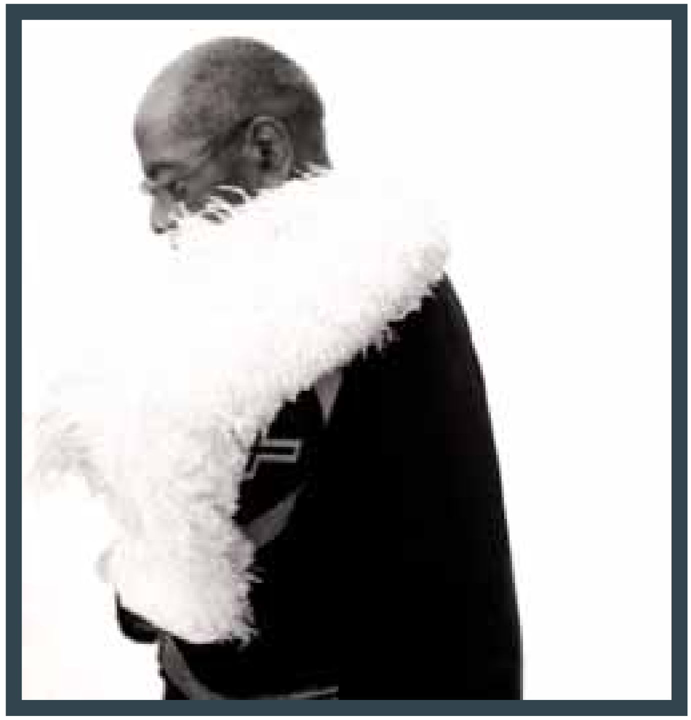
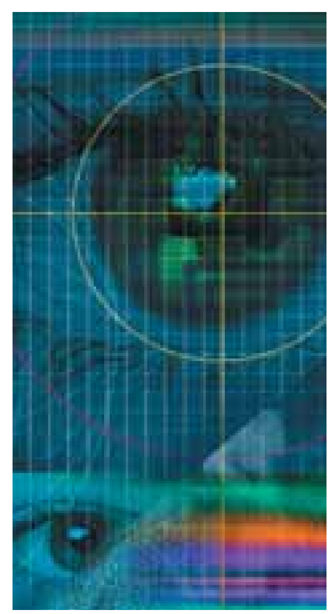
Premier

Profile



Prospectus

in Practice

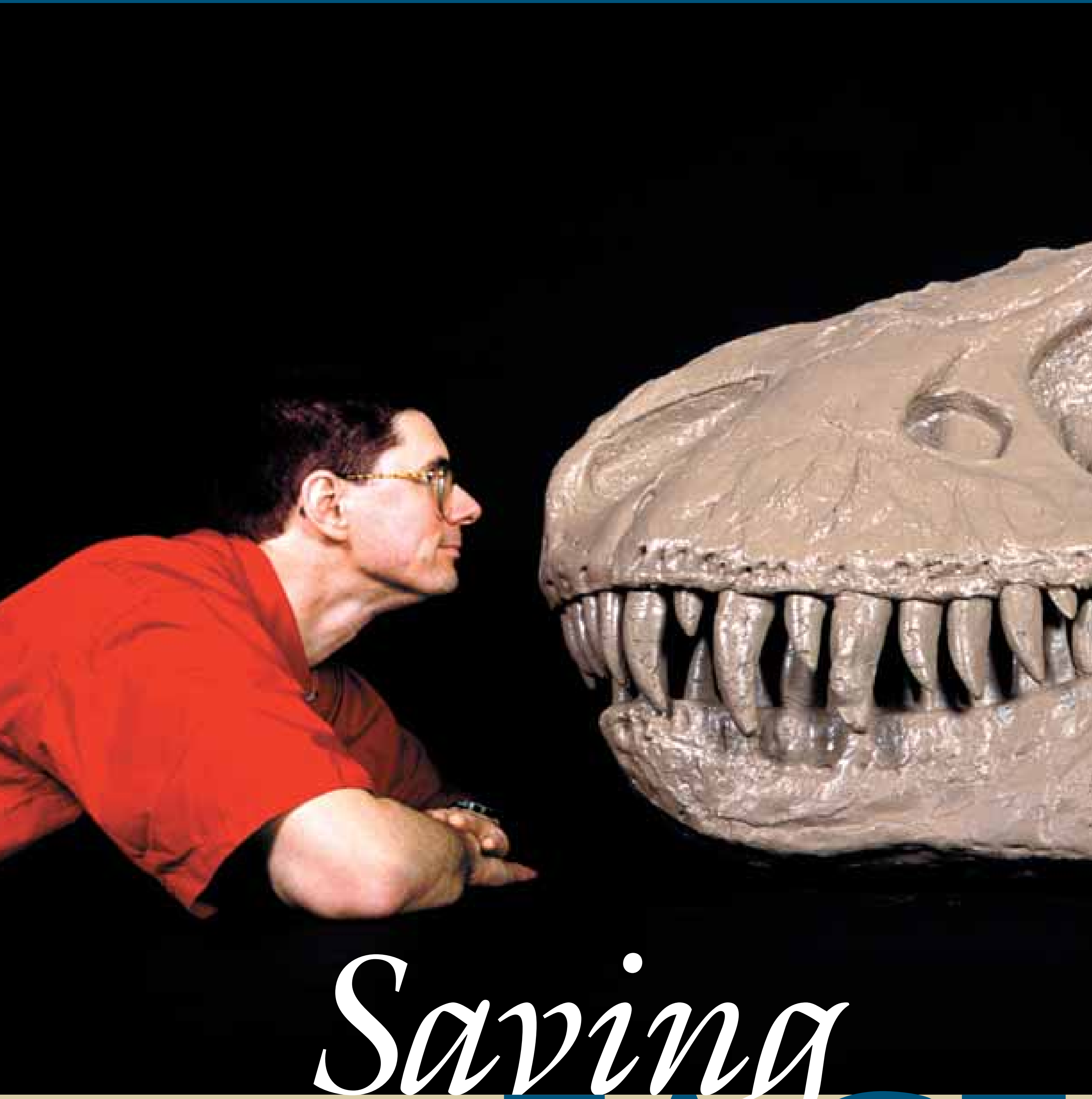


Postscript

(ON THE COVER) *Paleontologist Lawrence Witmer uses modern-day animals, such as this ostrich, to study the soft tissues of dinosaurs, such as* Velociraptor.
DIGITAL ILLUSTRATION: *Christina Ullman*
PHOTOS: *Jo McCulty*

(OPPOSITE PAGE) PHOTOS: *Christina Ullman*

(THIS PAGE) PHOTO: *Gary Kirksey*
DIGITAL ILLUSTRATIONS: *Christina Ullman*



Saving FACE

Paleontologist Lawrence Witmer is going nose-to-nose with dinosaurs such as Tyrannosaurus rex *in a study designed to recreate the soft tissues of the extinct animals.*

THERE WAS A TIME in 1997 when Sam Witmer was the most popular 4-year-old on his block. Tucked away inside the youngster's garage was a life-size replica of a *Tyrannosaurus rex* skull. The 4-foot-long mocha-colored shell was cast from a fossil of a mature adult. It had a mouthful of 60 jagged teeth, empty eye sockets, and holes and notches that hinted at the muscle and skin that once covered its surface.

As the son of a paleontologist with an overcrowded lab, this was run-of-the-mill stuff. Today, his father, Lawrence Witmer, has a little more lab space. And more room for dinosaurs. Over the last four years, Sam, now 8, has been up close and personal with the fossilized remains of *Triceratops*, *Diplodocus*, *Leptoceratops*, *Camarasaurus*, *Ankylosaurus*, and, of course, the *T. rex*, which now sits atop a cabinet in Witmer's lab.

While these wares may make Witmer a popular visitor on career day at his son's school, they also have led him to a different kind of notoriety. Among his peers, Witmer is known as the man who stripped the lips from *T. rex* and the cheeks from *Triceratops.* In August, he published a study featured on the cover of the journal *Science* on the correct placement of dinosaurs' nostrils, which no doubt sent artists once again to their drawing boards to recraft the faces of duck-billed dinosaurs and long-necked sauropods whose nostrils now would need to be drawn closer to the mouth instead of atop the head.

Witmer did not set out to create a new look for these extinct animals. It was the question of what was *inside* of dinosaurs that launched his research. How did they eat? Breathe? Smell? Exist in such enormity without falling over or boiling in their own blood?

When he began his studies, Witmer knew the answer to these questions could not be found in the bones that time and the elements encased in rock. To solve these queries, he needed to study the dinosaurs' soft tissues — muscles, veins, arteries, cartilage. The fossil record preserves only bone, so he turned to crocodiles and birds, the closest living relatives of dinosaurs. Their insides are still intact and can be easily studied. Soft tissues carve distinct marks in the bone. By comparing these bony signatures in modern-day animals to the fossils in his lab and museums around the world, Witmer could reconstruct soft tissues in dinosaurs. And then, he thought, he could figure out how the animals breathed, ate, smelled, walked, and made other dinosaurs.

And that's how it all began.

A quest to reconstruct dinosaurs' soft tissues is bringing the bones to life

TEXT BY KELLI WHITLOCK

PHOTOGRAPHY BY JO MCCULTY

FOSSIL FASCINATION

Well, truth be told, it began long before that. Most paleontologists recall a childhood fascination with dinosaurs that never ebbed. For Witmer, it began when he was 6. It was then, in 1966, that he saw his first dinosaur — a life-sized *T. rex* — at the traveling World's Fair exhibit in Rochester, New York. That sighting sparked a wonder in Witmer that only grew with time. One of the earliest influences on the budding paleontologist was Don Schultz, his ninth-grade Earth science teacher. Schultz would bring fossils to class, challenging Witmer to correctly identify them. The young student would scurry to the library, searching for information that would help him earn the prize for a positive ID: He would get to keep the fossil. Witmer still has the dozen or so fossils his teacher gave him for coming up with right answers.

But it was a master's project on the origin of birds that kicked off his research career in the field. While studying at the University of Kansas in the mid-1980s, Witmer dove head first into the controversy surrounding the evolution of birds. Did the winged animals evolve from dinosaurs as some scientists maintained? Witmer thought not, and his faculty adviser encouraged a scrutiny of soft tissues in modern-day relatives of dinosaurs as a method to uncover evidence not preserved in the fossil record. He analyzed the sinus regions of present-day birds, comparing the bony signatures left by soft tissues in those animals to similar markings in the fossils of the earliest birds. He then contrasted all these data with fossils of dinosaurs, and came to a surprising conclusion. He and his adviser were wrong.

"It was my own research that led me to the conclusion that birds evolved from theropod dinosaurs," he says, adding that while many scientists now concur that birds likely evolved from dinosaurs, some, including his former adviser, still argue against this theory.

Although his studies of the origin of birds continued, his comparison of modern-day animals to their prehistoric ancestors slowly took center stage. By the time he began his doctoral studies at Johns Hopkins Medical School, he knew that to learn more about how dinosaurs lived, he would need to know what they looked like beneath their tough skin. At the time, most scientists dismissed soft tissue reconstruction as too speculative.

"How can we understand the fossils unless we look at the soft tissues?" Witmer wondered then. But in the absence of a method strong enough to withstand scientific scrutiny, it seemed restoring dinosaurs from head to toe would be left only to the imagination of film directors, toy makers, and a few artists.

CLOTHING THE BONES

The slabs of dinosaur skulls that line the shelves, counter tops, and cabinet drawers in Witmer's lab today leave much to the imagination. With the aid of artists' recreations, the fully clothed images of such animals as *T. rex* inspire wonder — the rugged, green skin, dark eyes, imposing jaw lines. But without the artist's brush, the fossils are little more than bone or models of bone surrounding a bunch of holes. For Witmer, an anatomist and associate professor of biomedical sciences at Ohio University, these empty spaces hold the greatest intrigue.

"I can't just look at the holes in the heads and walk away because there's nothing there to see now. The bones are really there to provide support and protection for the soft tissues," Witmer says. "And the soft tissues are what I need to understand because they're what animate the bones."

So, before graduating from Johns Hopkins with a doctoral degree in cell biology and anatomy in 1992, Witmer not only honed his skills as a paleontologist, he perfected his acumen as an anatomist as well. Those combined skills prepared him for his mission to "clothe the bones" of the extinct animals he'd admired since childhood — and led him to describe a method for understanding dinosaur biology and behavior that he calls the Extant Phylogenetic Bracket (EPB for short). Witmer published his first paper on EPB in 1995, detailing a precise process for making assumptions — or inferences — about dinosaurs that could stand up to scientific review. EPB not only mapped out the path for paleontological study, it also made clear the necessity for soft tissue reconstruction.

EPB argues that scientists must obtain information in a certain order (see guide on page 18): Dissect modern animals to learn the anatomical details of the soft tissues they suspect dinosaurs also had; determine the bony signatures produced by the soft tissues; conduct a study of the fossils; reconstruct soft tissues by comparing markings in the fossils to similar markings in modern-day dinosaur relatives; study the organisms'

By studying X-rays and CT scans of dinosaurs such as Camarasaurus *(front) and* Majungatholus *(back), Witmer compares bony signatures on the fossils with similar markings on modern-day animals.*

functional morphology (how their form and structure influenced biological functions); examine dinosaurs' behavior and mode of life; and formulate an understanding of dinosaurs' paleoecological interactions with other species. Then, and only then, can scientists find the Holy Grail of paleontology — understanding dinosaurs' community structure and evolution. Skipping or moving too quickly through one level could — and has — resulted in false assumptions of dinosaurs' physical and biological make-up. (For example, Witmer's recent debunking of the theory that dinosaurs had nostrils high atop their heads.)

Since its first introduction to the scientific community, EPB has not been refuted. Most paleontologists have embraced it, saying the comparison of dinosaur remains to the animals' modern-day relatives affords an insight into dinosaurs that can be backed up with data. Others have criticized EPB as being too conservative, claiming the technique restricts speculation some say is mandatory in a field that examines animals gone from the Earth for millions of years. And some have chosen not to use the method, Witmer says, because the work is time-consuming and messy.

Witmer, a self-professed perfectionist, admits the technique is strict. The temptation for paleontologists is to hypothesize about how dinosaurs lived. Urged on by a public consumed with dinosaur mania, scientists often move up the inverted pyramid of inference without solid data to back them up.

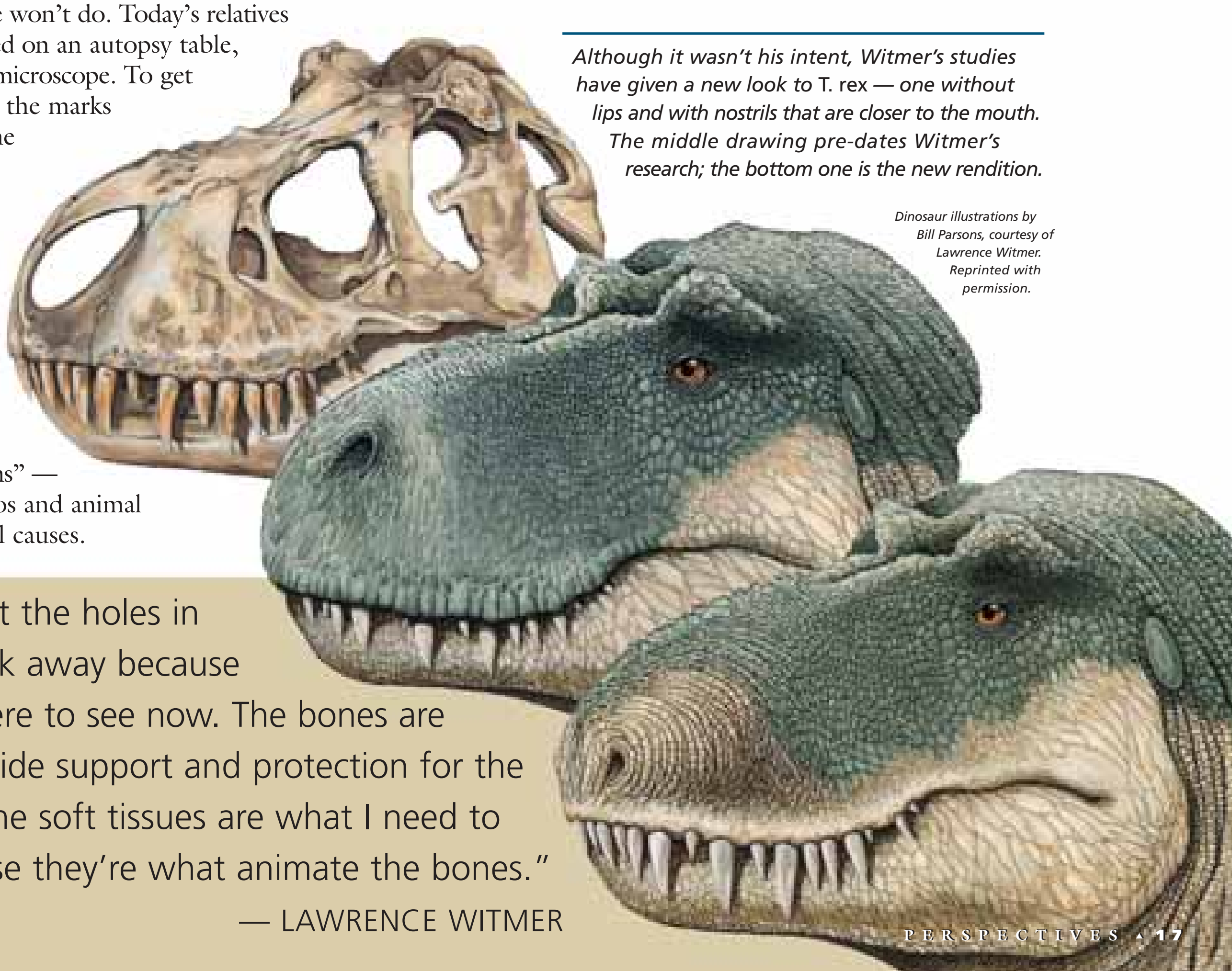
"EPB requires a lot of attention to detail, looking at the bones and recreating the soft tissues," Witmer says. "It requires something a lot of paleontologists are unwilling to do, and that is to look very closely at the anatomy and physiology of modern-day animals."

And just a passing glance won't do. Today's relatives of times past must be studied on an autopsy table, with scalpel, forceps, and microscope. To get close to the soft tissues and the marks they etch into the bone, the animals must be sent through an X-ray, a CT scan, or an MRI. Over the course of his research career, Witmer has dissected thousands of animals, ranging from manatees to ostriches to horses to hooded seals. The five freezers in his labs are filled with "salvage specimens" — animals sent to him by zoos and animal parks after dying of natural causes. This summer, he had an entire frozen ostrich and the head of a white rhino awaiting his attention. He also collects the bones of modern-day animals from unusual places to use in his studies. A hippo skull on a shelf in his office was purchased for $300 on eBay (beating out a bidder who planned to use it for a foot stool).

Once he's acquired the animals, he must prepare them for study, run scans, do an autopsy, strip the flesh and soft tissues, make note of markings the tissues left on the bones. When a dinosaur fossil arrives, it also must be scanned and examined, every groove in the bone mapped and logged. Witmer's shelves are lined with the skulls of the old and very old; his light tables decorated with X-ray films and scans. The lab smells of chemicals and bone.

"There's a squeamish factor to using EPB. A lot of people avoid it because it's a long, tedious process that's not as pleasant as working with a nice, clean fossil," says John Hutchinson, a scientist at Stanford University who studies locomotion in dinosaurs. But when Hutchinson read Witmer's 1995 paper on EPB, he was intrigued. He is careful to note Witmer wasn't the first to suggest dinosaur soft-tissue reconstruction was not only possible, but necessary to the understanding of the ancient beasts of the Cretaceous, Jurassic, and Triassic periods. But he credits Witmer with being the first to explain it in language everyone could understand.

"Other people have used very similar approaches and tried to outline a similar philosophy, but they just haven't been as clear," Hutchinson says. "Larry was the trailblazer, and now I see EPB at almost every paleontological meeting I go to. People have really jumped on the bandwagon."



Although it wasn't his intent, Witmer's studies have given a new look to T. rex *— one without lips and with nostrils that are closer to the mouth. The middle drawing pre-dates Witmer's research; the bottom one is the new rendition.*

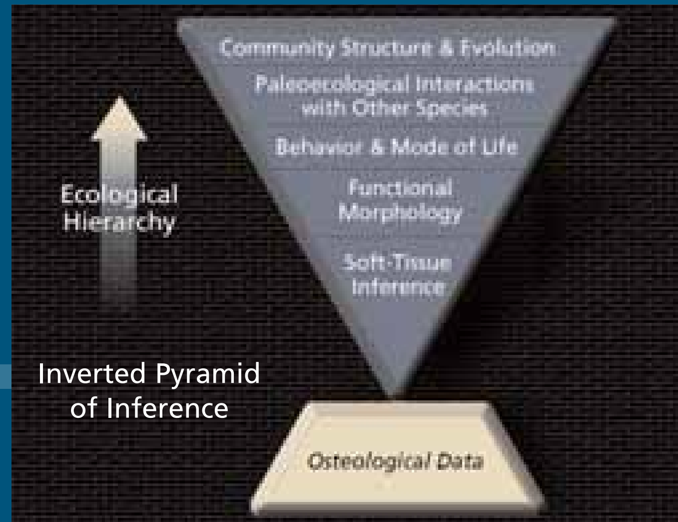
Dinosaur illustrations by Bill Parsons, courtesy of Lawrence Witmer. Reprinted with permission.

"I can't just look at the holes in the heads and walk away because there's nothing there to see now. The bones are really there to provide support and protection for the soft tissues. And the soft tissues are what I need to understand because they're what animate the bones."

— LAWRENCE WITMER

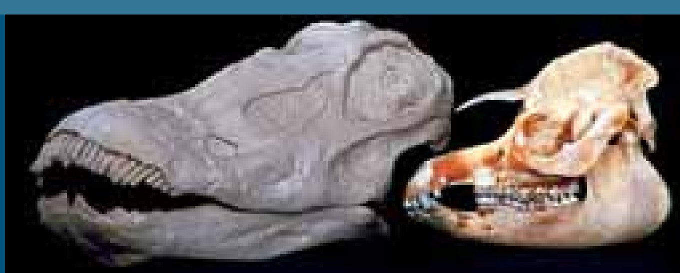
FACE *Off*

The Extant Phylogenetic Bracket (EPB) was developed by Witmer in the early 1990s as a process for making assumptions, or inferences, about dinosaurs that could withstand scientific test. EPB argues that information must be obtained in a certain order, leading scientists through an inverted pyramid of inference. Skipping a step can lead to inaccurate inferences — mistakes that are amplified up the pyramid.



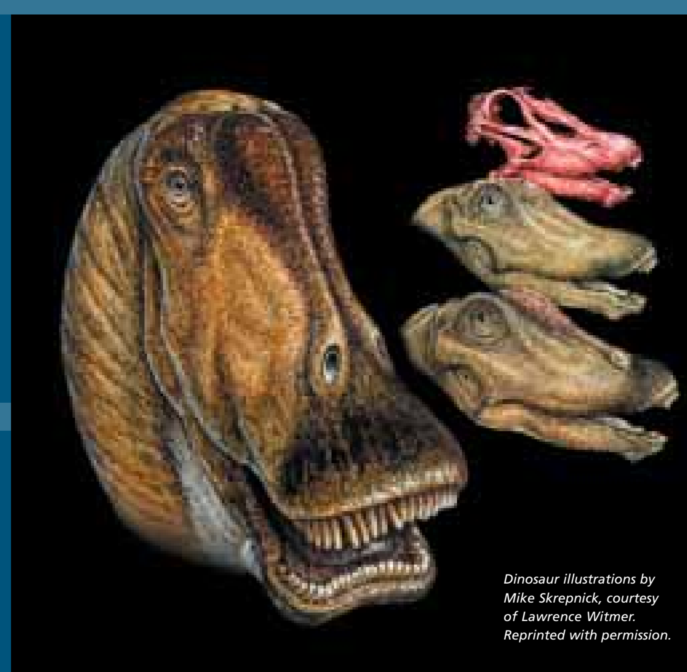
1 The process begins with the anatomical study of modern-day relatives of dinosaurs, teasing apart the details of the soft-tissue trait a scientist suspects the extinct animals also had. After conducting an autopsy and noting position of soft tissues and organs, Witmer prepares the modern-day bones for examination with boiling, chemicals, or with dermestid beetles, which clean the bones quickly and very thoroughly.

2 Before removing the soft tissues and organs, Witmer often creates a plastic cast of veins, arteries, and organs in the modern-day animals he studies, such as this alligator. He later refers to the polymer tracings when trying to recreate similar tissues in dinosaurs.



3 Bony signatures in fossils (such as Diplodocus*) can be compared to similar markings in modern-day animals (such as this tapir), offering detail about the soft tissues that etched the markings in the bone.*

4 To get an inside look at the fossils (such as this Diplodocus *skull on loan from the Carnegie Museum) and modern-day bones, Witmer runs them through a CT scan or X-ray machine — even an MRI — at O'Bleness Memorial Hospital in Athens.*



Dinosaur illustrations by Mike Skrepnick, courtesy of Lawrence Witmer. Reprinted with permission.

5 The data from Witmer's studies sometimes require giving dinosaurs a new — and more accurate — look. Among the latest dinosaurs to be redrawn from his research is Diplodocus*, which now is drawn with the nostrils closer to the mouth. For Witmer, the key point about the correct placement of the openings is what it tells him about the dinosaur's respiratory system.*

> "EPB requires a lot of attention to detail, looking at the bones and recreating the soft tissues. It requires something a lot of paleontologists are unwilling to do, and that is to look very closely at the anatomy and physiology of modern-day animals."
>
> — LAWRENCE WITMER

That's not to say that all paleontologists are engaged in soft-tissue reconstruction.

"Some people aren't after questions that would require the EPB approach," Hutchinson says, adding that for scientists interested only in fossils, EPB holds little interest. In fact, he estimates that of the 50 or so scientists involved with dinosaur reconstruction around the world, only about 15 use the EPB technique regularly.

"But for people who are interested in behavior and paleoecology," Hutchinson says, "working your way up the pyramid is a must."

It's a slow ascendance requiring a degree of patience that, to a passerby, might seem unlikely for Witmer. The 42-year-old rarely remains motionless. His 5-foot-11 lean frame moves from room to room with an energy that comes from a passion for learning about animals. There is always something demanding his attention: e-mails from a news media forever enamored of dinosaur science; questions from students who do research in his lab; an anatomy lab practical for would-be doctors in the university's College of Osteopathic Medicine; the snout of a gharial crocodile that's just arrived from India; a *Stegosaurus* on loan from the Smithsonian.

Despite his outward appearance of a man on the go, Witmer can sit for hours hunched over a specimen, delicately peeling back the layers of tissue or fingering the notches of bone that have helped him change the way we look at dinosaurs.

"CHEEKS, BEAKS, AND FREAKS"

"People like to think of dinosaurs as looking a certain way, and often times, they're given traits that are more familiar, more comfortable," Witmer says. "As a scientist, I'm certainly not out to change dinosaurs' appearance. But what our studies are doing is allowing the true uniqueness of the animals to emerge."

This emergence began in the fall of 1998, when Witmer presented findings at the Society of Vertebrate Paleontology annual meeting. In his paper, which he playfully titled "Cheeks, Beaks, and Freaks," Witmer claimed the most ferocious carnivore of the Jurassic, *Tyrannosaurus rex*, consumed his prey without the need of lips.

T. rex has long been likened to modern-day lizards thought to have muscular lips. Lizards have scales that Witmer says hang down along the edges of their jaws and hide the lizards' teeth when their mouths are closed. However, this isn't necessarily so with tyrannosaurs and other predatory dinosaurs. These animals had skin that probably extended to the margin of their jaw but didn't extend to cover their teeth (see artist's rendering on page 17).

Witmer didn't stop with tyrannosaurus' chops. Findings he presented three years ago also put a new face on *Triceratops* and *Leptoceratops*. These dinosaurs, both ornithischians, have long been thought to have had fleshy cheeks, which scientists believed were involved in how these plant-eaters ate. The idea that they had cheeks was based on scientists' comparison of these dinosaurs to modern-day mammals, such as sheep.

The dinosaurs probably were about the same size as sheep — *Leptoceratops* is thought to have been about 6 to 8 feet in length, weighing between 100 and 150 pounds — and most likely enjoyed the same plant-based diet. Sheep, like all mammals, have fleshy, muscular cheeks. Scientists who compared the animals to ornithischians operated under the assumption that these dinosaurs had the same muscular cheeks as sheep. Biologically, it seemed to make sense. Muscular cheeks would have played a significant role, scientists thought, in how ornithischians chewed.

To establish more reliable data for the cheek theory, Witmer and his students compared bony signatures from modern-day mammals with cheeks — moose, bison, horses, beavers, and other cheek-boasting animals — with those of *Triceratops* and *Leptoceratops*. Studies of fossil remains of ornithischians suggest these dinosaurs had gouged out areas on the upper and lower jaws resulting in the teeth being rooted in the surface of the skull. The presence of cheeks would explain this jaw structure, so scientists claimed ornithischians had cheeks.

But Witmer's studies have found this comparison to be false: Modern mammals with muscular cheeks do not have the same sort of excavated area on their lower and upper jaw that is found in dinosaur fossils. "Thousands of herbivore species today are highly successful, even without cheeks," he says, including many birds, lizards, and turtles.

So what caused the notches in the jaw bones? A more likely conclusion, Witmer says, is that these jaw features supported an extended beak, similar to the beaks on eagles or turtles.

"The conclusion also suggests we need to re-examine the feeding apparatus of ornithischians," Witmer continues, "which was based on the assumption of cheeks."

AS PLAIN AS THE NOSE...

To the average dinosaur enthusiast, it may seem like an arbitrary question: Where, exactly, were dinosaurs' nostrils? But according to Witmer's latest study, published this summer in *Science*, the answer could help explain how the creatures found food, detected predators, reproduced, and regulated brain and body temperature.

Once again, Witmer's studies have given many dinosaurs a new look: Nostrils once drawn on the top of some dinosaurs' heads now appear just above the mouth. The new face captured wide public and media interest — stories ran in London, Germany, Russia, Sweden, and across the United States, most notably a front-page piece in *The New York Times* and a live interview on CNN. (For Witmer, however, the most important story ran in his New York hometown newspaper, the *Rochester Democrat and Chronicle*, on a news tip from his father.) But for scientists, the impact is more than skin deep.

FACE *Forward*

To take a look inside Witmer's lab, point your Web browser to *www.ohiou.edu/sciencespotlight*, the site for a new TV science series launched this fall. Witmer was the subject of the first in the series, which can be seen via the Web and on WOUB-TV in southeastern Ohio and parts of Kentucky and West Virginia. The project is a collaboration among WOUB, the Office of Research Communications, and University Communications & Marketing.

"Reconstruction of soft tissues harkens a new era in paleontology. People are always asking, 'Don't we know everything about dinosaurs?' and the answer is 'No.'"

— SCOTT SAMPSON, curator of vertebrate paleontology at the Utah Museum of Natural History

"The public has always been interested in dinosaurs because they're so huge. Scientists have been interested because dinosaurs really seem to stretch the bounds of physiological form," Witmer says. "By looking at the noses of dinosaurs and their modern-day relatives, we've potentially been able to provide some answers to how these animals could have survived being so large."

The latest findings from his efforts to reconstruct soft tissues in dinosaurs, a study dubbed the "DinoNose Project" and funded by the National Science Foundation, place dinosaur nostrils a significant physiological distance from where scientists once thought the openings lay.

That misconception dates to the earliest recovered dinosaur fossils, many of which belonged to sauropods. The enormity of these long-necked brontosaurs — some weighing as much as 70 to 80 tons — was matched only by whales, so early paleontologists assumed sauropods also must have been aquatic animals. Nostrils high on the forehead would have allowed the dinosaurs to breathe while partially submerged. The assumptions were reinforced with the 1884 discovery of an intact skull of the sauropod *Diplodocus*, which revealed a large hole at the top of the head that scientists believed held the entire nasal cavity.

"Despite the fact that many years later we realized sauropods weren't primarily aquatic, we never addressed the nostril position again," Witmer says. "And somehow, we translated that nostril position to other dinosaurs."

But Witmer's studies suggest the nasal region of dinosaurs is much larger than previously thought, and the hole paleontologists once said was a nostril actually was just one part of the nasal cavity. The fleshy nostrils, he discovered, actually lay farther forward and closer to the mouth. And not just in the sauropods, where the change is most visually evident, but in all dinosaurs.

"The change in nostril position is indeed most striking for sauropods, but it also will make a big difference for horned and duck-billed dinosaurs," Witmer suggests. "Biologically it'll make a huge difference for all kinds of dinosaurs."

Many of the large dinosaurs Witmer has studied — *Diplodocus* was 80 to 90 feet long and weighed more than 40 tons — had highly vascular nasal cavities that took up more than half of some of the animals' skulls. Such a complicated nasal structure would be involved in a host of biological functions: Conditioning, humidifying, and filtering air on its way to the lungs, the exchange of gases, and regulating brain and body temperature.

The position of the nostrils is key to the organization of the entire respiratory system. If the nostrils of dinosaurs were in the back, as paleontologists once believed, this complicated nasal system couldn't have participated in many of the animal's basic biological functions.

Having nostrils down front offers many other evolutionary advantages as well, Witmer adds. Smell is very important for animals that must rely on scent to find a mate, detect a predator, and find food. And close proximity between two such strong collectors of sensory information — the nostrils and the mouth — makes sense from a physiological standpoint. But this wasn't the evidence that convinced Witmer that dinosaurs' nostrils had been positioned incorrectly.

For this project, Witmer studied 62 animals from 45 species of crocodiles, birds, and lizards, documenting the placement of soft tissues through dissection and hundreds of X-rays. He compared the bony signatures of these modern-day animals to similar markings on fossils from dozens of dinosaurs, and mapped the likely position of cartilage, blood vessels, and other soft tissues that made up the nasal cavity of dinosaurs.

"We looked at as many modern-day animals as we could get a hold of," Witmer says, "and found an extraordinary amount of evidence to suggest the nostrils of dinosaurs actually were parked out front."

What's more, the common "up-front" placement of fleshy nostrils in the reptiles, birds, and mammals Witmer studied suggests an unusual anatomical trait consistent among these animals. This adds yet another evolutionary twist to Witmer's research, which is offering as much insight into modern-day animals as it is for animals that have been extinct for millions of years.

"Reconstruction of soft tissues harkens a new era in paleontology," says Scott Sampson, curator of vertebrate paleontology at the Utah Museum of Natural History and a paleontologist at the University of Utah. Sampson and Witmer are collaborators on the DinoNose Project. "People are always asking, 'Don't we know everything about dinosaurs?' and the answer is 'No.'"

MARKETING THE PAST

A few years ago, Witmer took his son to see Disney's animated feature *Dinosaur*. As with most films of this genre, the animals talked and had likable personalities. Now, Sam Witmer certainly knew that dinosaurs didn't really talk. What kid doesn't know that? But being the son of the man who was changing the face of the stars of this movie, he understood something other kids in the audience didn't. As the picture was just starting, Sam leaned over to his father, whispering, "Hey, Dad, too bad about those cheeks, huh?"

Witmer studies fossils and casts of dinosaurs on loan from museums and laboratories around the world. This cast of the Mongolian dinosaur Altirhinus *(literally "tall nose") displays the huge nasal apparatus typical of this group.*

Hollywood's depictions of dinosaurs may be recognized for their special effects wizardry. But the film industry rarely scores high marks for scientific accuracy. *Jurassic Park*'s *Triceratops* was too big and *Velociraptors* couldn't really use their arms to open doors. (Not to mention the lips, cheeks, or nostril placement.)

"As scientists, we understand that media portrayals of dinosaurs are often distorted," Witmer says. "But these popular portrayals of dinosaurs can come back to haunt the scientists. We may be carrying biases that are not generated by science, but rather by the portrayal of science in the media, movies, or toy industry."

That makes it all the more important that findings such as those emerging from Witmer's lab find their way to dinosaur scientists — and dinosaur artists.

"We have whole industries that relate to the popularization of dinosaurs. It's a multibillion dollar industry," Witmer suggests. "Sometimes the science will stick in the craw of the artists or an art director — someone who has to make a decision about how an animal should look. If there are commercial interests, the science will go out the window. We've seen that in films."

And while this is bothersome, Witmer says it doesn't prevent him from enjoying dinosaurs in the marketplace. (He has seen all three *Jurassic Park* films, owns several dinosaur ties, has a puppet *T. rex*, a "Paleontologist Barbie," and dozens of plastic dinosaurs and their modern-day relatives in his office, all gifts from family and friends.)

"When I'm with my son, I'm more of a father than a scientist," he says. "If he's enjoying a movie, the last thing I want to do is detract from his experience by nitpicking."

Still, he admits shyly, there was a moment of parental pride when Sam saw through Disney's attempt to put cheeks on *Triceratops.*

THE REST OF THE STORY

Witmer cleared a significant hurdle on his career track earlier this year: He received tenure in June. With that behind him, he is moving ahead with his studies. In work he hopes to publish in the coming year, Witmer plans to offer an EPB-derived theory that could solve the mystery of how the largest dinosaurs regulated body and brain temperature. And although his analysis of data collected during the DinoNose Project will continue for years to come, he now is expanding his research to other parts of dinosaurs' anatomy.

One study nearing completion has focused on dinosaurs' limbs, a project that Witmer says will help him figure out how the animals moved and describe their posture. An incidental finding of this project could, he says, lead him to add a couple of inches or feet to the height of many dinosaurs, an outcome that would impact museum exhibits around the world.

Another effort is examining how dinosaurs ate, which Witmer says is "one of the most central biological functions any organism has." Through soft-tissue reconstruction of the jaw muscles — and inspection of possible bones from the tongue area — Witmer hopes to develop a better understanding of how the animals fed.

From there, who knows?

"One of the big questions for me is 'What are the limits of what we can know?'" he wonders. "Part of my job is not only to find the answer, but to find the answerable. Can we find out about things such as dinosaur tongues? Maybe the answer is no. But my previous experience with soft tissue reconstruction is never say 'Never.'" ▲

For more information on Witmer's research, visit his Web site at *www.oucom.ohiou.edu/dbms-witmer/index.htm*. To read other news articles about his studies, search the Office of Research Communications' Web site, keyword "Witmer."

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