

Paleontology and Evolution in the News

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It may come as a surprise to you that the raptor-like *Archaeopteryx*, usually considered to be the first bird, is actually a lot less bird-like than scientists had believed. In a press release from Florida State University (www.fsu.edu/news/2009/10/09/first.bird) reporting on the study by Gregory M. Erickson, paleobiologist of Florida State University, the image of *Archaeopteryx* as the iconic first bird living 150 million years ago in the Late Jurassic Period in what is now Germany has been recast as more of a feathered dinosaur. That's because new, microscopic images of the ancient cells and blood vessels inside the bones of the winged, feathered, claw-handed creature showed unexpectedly slow growth and maturation that took years, similar to that found in dinosaurs, from which birds evolved. In contrast, living birds grow more rapidly and mature in a matter of weeks. Dr. Erickson said, "From these findings, we see that the physiological and metabolic transition into true birds occurred millions of years after *Archaeopteryx*. But perhaps equally important, we've shown that avians were able to fly even with dinosaur physiology." The study is published in the Oct. 9, 2009, issue of the journal *PloS One* (www.plosone.org). In addition to Erickson, an associate professor in Florida State's Department of Biological Science and a research associate at the American Museum of Natural History, co-authors include Florida State University biologist Brian D. Inouye and other US scientists, as well as researchers from Germany and China. Responding to the Florida press release, John Noble Wilford wrote "Paper Challenges Idea

About 'Early Bird Dinosaurs'" in the *New York Times*, Friday, October 9, 2009 ([www.nytimes.com/2009/10/09/science/09fossil.html?scp=1&sq=wilford early bird&st=cse](http://www.nytimes.com/2009/10/09/science/09fossil.html?scp=1&sq=wilford%20early%20bird&st=cse)). In the article Mr. Wilford describes the historical importance of *Archaeopteryx*, a specimen of which was first found in 1860, in southern Germany, about a year after the publication of Darwin's *Origin of Species*. The discovery at that time swayed many scientists toward accepting the theory of evolution by natural selection. The article also contains several brief statements from scientists involved in the research, as well as some who are not. In the scientific paper, the research team concluded that *Archaeopteryx* "was simply a feathered dinosaur that might have been capable of some aerial behavior, though perhaps not powered flight. In short, despite the feathers, it was not the archetypal bird." Paleontologists who were interviewed but not involved in the research said the findings were an important step in dinosaur-bird studies but not surprising. The bone growth, the basis for some of the conclusions in the research paper, was unbirdlike but reflected metabolic rates greater than those in nondinosaurian reptiles; that is they were more warm-blooded than cold-blooded.

Dinosaurs, and especially *Tyrannosaurus rex*, always hold a place among their top five favorites on people's (as well as the press') list of charismatic fossils and probably for animals in general. So when a new fossil is discovered, such as the fascinating one described below, it becomes big news. A new tyrannosaur, a new genus and species, *Raptorex kriegsteini*, is smaller (3 meters) than the largest *T. rex* (which has a length of 12.8 meters). The new species has several key features previously known only in the Tyrannosauridae, providing a glimpse at how this family evolved. The discovery and description was formally published in *Science* (www.sciencemag.org) vol. 326, pp.418–422, on October 16, 2009, "Tyrannosaurid Skeletal

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Design First Evolved at Small Body size,” by Paul C. Sereno and several others. A summary of the article and other perspectives related to the specimen was published by James Clark in the same issue (pp. 373–374). The specimen comes from northeastern China, an area known for the preservation of a dinosaur with feathers, although the exact locality remains unknown. “The *Raptorex* specimen was purchased a few years ago by Henry J. Kriegstein [one of the co-authors of the paper] at the Tuscon Gem and Mineral Show, a venue notorious for the sale of illegally collected fossils...Kriegstein approached Sereno with the fossil and Sereno agreed to describe it on the condition that it would be deposited in a collection in China.” The article further discusses the ethics of stolen fossils and, for that matter, any illicitly gained objects. Most of what we know about dinosaurs is tilted toward the end of the Mesozoic Era, the Late Cretaceous rather than the Early Cretaceous or Jurassic. With the discovery of the new fossil, it turns out that tyrannosaurs are a member of a group of theropod dinosaurs called coelurosaurs, a group from which birds also evolved, but not the theropod dinosaurs such as *Allosaurus* of the Late Jurassic, which had been previously designated as the progenitor of *T. rex*. A discovery of this magnitude of a fascinating group of dinosaurs would obviously make it to the newspapers. Henry Fountain on September 18, 2009 ([http://community.nytimes.com/comments/www.nytimes.com/2009/09/18/science/18dinosaur.html?scp=2&sq=Henry Fountain fossil&s](http://community.nytimes.com/comments/www.nytimes.com/2009/09/18/science/18dinosaur.html?scp=2&sq=Henry+Fountain+fossil&s)) described the discovery. The earlier date reflects the fact that the paper was first published online. He nicely summarized aspects of the discovery, writing that “Sereno said the fossil was that of a young adult, about 5 or 6 years old and near the end of its growth period. It had long shin bones and long, compressed feet that helped it run fast after smaller dinosaurs and other prey.” This three meter-long animal weighed only 150 pounds and lived 125 million years ago, about 35 million years before *T. rex*.

No sooner than the above study was published than a press release from the Natural History Museum (London) (www.nhm.ac.uk) on November 4, 2009 described a report about a specimen with a close evolutionary relationship with *Raptorex*. The fossil *Proceratosaurus* was found almost 100 years ago, during 1910, in excavations for a reservoir in Gloucestershire. Originally, it was described as a new species of *Megalosaurus* and remained as such until the present time, not linked previously with tyrannosaurs. It turns out that it is a *Proceratosaurus*, a 165-million-year-old ancestor of *T. rex* that lived around 67–65 million years ago at the end of the Cretaceous Period, but *Proceratosaurus*, a much smaller animal, was probably nine feet long and lived about 100 million years earlier. “This new dinosaur gives scientists important clues about the early stages of the evolution of these fearsome predators.” The study by Oliver Rauhut, Angela Milner and Scott Moore

Fay was published in the *Zoological Journal of the Linnaean Society* on November 4, 2009 (<http://www.wiley.com/bw/journal.asp?ref=0024-4082>). The 14-inch delicate skull was newly prepared, and a computer tomography (CT) scan enabled the researchers to create 3D images of the fragile skull, which allowed them to study its internal structure in minute detail. The scans were taken at the University of Texas at Austin. As a result, they found that its teeth, jaws and braincase closely resembled the structures found in the gigantic *T. rex*. Robin Lloyd on November 4, 2009 in *Scientific American* (www.scientificamerican.com) added some additional information related to this unique specimen. *Proceratosaurus* was bipedal and weighed between 28 and 36 kilograms, very small when compared to the 8000-kilogram *T. rex*. Only the skull is preserved, which possesses a nose horn and four ferocious-looking, serrated snout teeth. The age of this theropod dinosaur extends the origin of coelurosaurs back into the Middle Jurassic and provides evidence for an early Laurasia-wide dispersal of the Tyrannosauoidea during the late Middle to Late Jurassic.

Sharks, especially the types that attack and eat people, hold a fascination of either dread or interest in their behavior and evolution or both. The great white shark is probably number one in that category, with a reputation enhanced by theatrical films and videos on YouTube (<http://www.youtube.com/>). From a scientific point of view, the evolutionary origin of this predator of the sea remains in dispute; namely: was its ancestor the extinct megatooth sharks such as *Carcharodon megalodon* or was it the extinct mako shark *Isurus hastalis*? Kevin Nyberg and George Wray of Duke University and Charles Ciampaglio published “Tracing the Ancestry of the Great White Shark, *Carcharodon carcharias*, Using Morphometric Analyses of the Great White Shark” in the *Journal of Vertebrate Paleontology*, volume 26 (4), pp. 806–814, 2006, where they conclude that the great white shark evolved from an extinct lineage of mako sharks. The conclusion is based on morphometric analyses and fine structure of the teeth using scanning electron micrographs that revealed such features as serration density, size and shape, and other characteristics of the examined specimens. At the time that this item was written, Google News (<http://news.google.com>) listed 1819 results for the white shark, most referring to attacks. Sean B. Carroll, a molecular biologist and geneticist and also the author of several popular books, most recently, *Remarkable Creatures: Epic Adventures in the Search for the Origin of Species* (Houghton Mifflin Harcourt, 332 pages, 2009) wrote in the *New York Times*, *Science Times* section, about the paper referred to above (http://www.nytimes.com/2009/09/15/science/15creature.html?_r=1&scp=4&sq=shark&st=cse). The article not only contains the results of the study, but like a good storyteller and good reporter, the author provides

additional information—in this instance, of interest to the teacher and student. As long ago as 1835 people associated the great white shark with megalodon, but prior to that some people believed that the fossil teeth were the tongues of dragons. The 1835 date is significant because it was then that Louis Agassiz, a paleontologist who worked on living and fossil fish, associated the living great white shark with megalodon. It should be noted that Agassiz made other significant scientific contributions, especially his studies of glaciers, which substantiated advancements which helped to modernize geology. A well known popular writer, he nevertheless rejected Darwinism and probably was the last scientist to do so, but he also made lasting contributions to evolutionary biology and systematics.

The British Council (www.britishcouncil.org) hosted an international conference on evolution and society, “Darwin’s Living Legacy,” on November 14–16 in Egypt. It was another event that celebrated the anniversary of Darwin’s birth (200 years ago) and the publication of *On the Origin of Species* (150 hundred years ago). The conference at the Bibliotheca Alexandrina was considered unusual because it was held in a country with little perception of Darwin. The purpose of the conference was “to promote an informed dialog about evolutionary science grounded in a mutual respect for differences in ideas, cultures and religious beliefs.” Speakers from more than 30 countries discussed themes such as “Evolution, Modern Science and Fundamental Belief Systems” and “Evolution, Politics and Media in Turkey.” Michael Slackman reported in the *New York Times* a description of aspects of the meeting, “Harnessing Darwin to Push an Ancient Intellectual Center to Evolve” (www.nytimes.com/2009/11/26/world/middleeast/26egypt.html?_r=1&scp=10&sq=slackman&st=cse), a title that may seem a little obscure. The ancient intellectual center refers to the “New Library of Alexandria” housed in a very modern oval-looking structure that is designed to recapture the spirit of openness and scholarship of the original Bibliotheca Alexandrina. For a full description of its contents and programs see www.bibalex.org/English/Overview/overview.htm. The website also provides “Darwin Now,” a 3 ½ minute video interview with Randal Keynes, great, great grandson of Charles Darwin, who speaks about the 150th anniversary of the publication of the *Origin of Species*. Getting back to Michael Slackman’s article, he reports that “It is not that Charles Darwin and the theory of evolution are unknown here. But even among those who profess to know something about the subject, the common understanding is that Darwin said man came from monkeys.” A discussion of Darwin is not only subject to the understanding of the origin of man but “inevitably” it includes a debate between religion and science. That is precisely why the British Council decided to hold an international conference

of Darwin, for the first time, in this conservative, Sunni Muslim nation.

Beyond describing the actual proceedings of the conference, Mr. Slackman writes about what is considered a more fundamental problem: the education system in Egypt and the region, which prizes and nurtures conformity, while challenging conventions and beliefs is anathema. “Education is based on rote memorization, with virtually no emphasis on creative thinking. Few schools here even teach the theory of evolution.” He also reports that many people attending the meeting were somewhat surprised that the government even agreed to allow the conference.

I was delighted to come across an article in the *Irish Times* (www.irishtimes.com/newspaper/sciencetoday/2009/11/19/1224259098359.html) for November 19, 2009 by William Reville because it discussed a publication that I had missed previously, at the beginning of the year, in the journal *Nature*. The publication, “15 Evolutionary Gems” by Henry Gee, Rory Howlett and Philip Campbell (www.nature.com/nature/newspdf/evolutiongems.pdf) briefly describes 15 examples published in *Nature* over the past decade that offer powerful evidence for natural selection as the mechanism of evolution. The 16 pages of the publication are divided into four sections: Fossil Record (five articles), From Habitats (six articles), and Molecular Processes (four articles). The authors state that these 15 examples published by *Nature* illustrate the breadth, depth, and power of evolutionary thinking. They offer this resource freely and encourage its free dissemination. The individual articles contain references for the “gems” and include additional resources that provide deeper understanding. Good illustrations are included that can enhance the use of this publication in the classroom and elsewhere (colleagues, friends, and loved ones).

During February, 2009 the following month, A. Tomescu, Humboldt State University, wrote a letter published in the Correspondence section of the journal (*Nature*, Vol. 457, February 19, 2009) complaining that there was a conspicuous absence of plants (not to mention invertebrates and microorganisms) from the list of “gems.” Plant blindness—a lack of awareness of and interest in plants in biology education and among the general population—is well documented. The risk of not including plants sends a wrong message, such as, there suggesting there is insufficient evidence for plant evolution (“or worse, that plants are not important.”) “Darwin’s ideas on evolution were in part based on, and in turn influenced, his study of plants.” His “abominable mystery,” the perceived rapid diversification of flowering plants, “still remains an important question in evolutionary biology.”

It is not often that I, or for that matter the news media, get to report on the discovery of new fossil crocodiles. But a major study published about them received worldwide

attention—so much that Google (www.google.com) reported 280 news articles in a variety of outlets within three days of its debut, beginning November 19, 2009. The monograph, “Cretaceous Crocodyliforms from the Sahara,” by Paul Sereno, University of Chicago and Hans Larson, McGill University, Montreal, published in *ZooKeys*, (vol. 28, pp. 1–143) (<http://pensoftonline.net/zookeys/index.php/journal/article/view/325>), is a study of a fascinating, diverse fossil crocodile fauna that inhabited the present-day Sahara some 100 million years ago. The discoveries included three new species and additional specimens of two previously named types. *ZooKeys* (<http://pensoftonline.net/zookeys>) is a peer-reviewed, open access academic journal supporting open and free exchange of ideas and information in systematic zoology. All papers in *Zookeys* may be freely copied and downloaded, printed and distributed at no charge to the reader.

The fossils were found in Morocco and Niger and have some unique anatomic features that lead to providing individual nicknames (apparently a common indulgence these days). See “Fun With Nicknames for Ancient Crocodiles” by Kenneth Wang in the *New York Times* ([www.nytimes.com/2009/11/24/science/24obfossil.html?scp=1&sq=kenneth chang nicknames&st=cse](http://www.nytimes.com/2009/11/24/science/24obfossil.html?scp=1&sq=kenneth%20chang%20nicknames&st=cse)). November 24, 2009. An 18-foot specimen was given the name BoarCroc because it had tusks that stuck out above and below its jaw like a wart-hog. Other new forms are named RatCroc, DogCroc, DuckCroc and PancakeCroc. It is believed that *Kaprosuchus saharicus*, found in Niger, included dinosaurs in its diet. Because the press release contained somewhat humorous descriptions, the news conference at *National Geographic* headquarters in Washington was well attended by various newspapers and AP, Reuters, UPI, etcetera, the story spread quickly through 280 media outlets including radio, TV news stations, and blogs, bringing worldwide attention to these fossils. (See, for example, “Fossils of dinosaur-eating crocodiles discovered,” in the *New Zealand Herald*. (www.nzherald.co.nz/world/news/article.cfm?c_id=2&objectid=10610499&pnum=1) published the day after the press conference on November 20, 2009.)

National Geographic sponsored the research, and an article by Sereno will be published in their magazine (www.nationalgeographic.com) by the time you will have read this column. A film of the expeditions to Africa and the discovery of the fossils was broadcast on National Geographic’s cable channel on November 21.

As a result of the publicity, *ZooKeys* had 11,548 visits to view the publication in the first two days. With a video posted on the National Geographic website, the easy availability of the scientific publication and articles in newspapers and magazines makes it easy for the educator to develop a lesson about these crocodiles that lived in

Gondwana in the southern hemisphere and disappeared in the great extinction that wiped out the non-avian dinosaurs 65 million years ago. In addition, some accounts also include comments made by the researchers that contain interesting observations about their work. See, for example, Randolph E. Schmid in (www.google.com/hostednews/ap/article/ALeqM5hRNvZn0XR0CBEJlkpkEkxnJC2NbQD9C2QJJ00).

Mark Haynes wrote the following story “Dino find may change thinking on migration” in *The Salt Lake Tribune* (www.sltrib.com/news/ci_13827849) on November 20, 2009. The Grand Staircase-Escalante National Monument has yielded new fossilized treasures that a scientist says could help rewrite what is known about paleontology in North America. “What we found will make us rethink what we know about [dinosaur] biology, ecology and migration,” said Alan Titus, paleontologist with the Bureau of Land Management, which oversees the 1.9-million-acre monument in southern Utah. Titus said bones ferried out by helicopter on Wednesday represent work performed last summer on a recently discovered site that could be the most significant yet discovered on the monument. “It’s the biggest accumulation of bones we’ve found on the Kaiparowits Plateau,” said Titus of the site, found in 2007. “We’re finding [dinosaurs] we did not know existed five years ago. All the different [species] are really helping bring the picture into focus.” In the past decade, Titus said, 2,600 sites have been discovered on 50,000 acres of the monument in Kane and Garfield counties. But few have been as rich as the latest site. “It’s easily in the top three sites we’ve found,” he said. “We’re finding five or six different [dinosaurs] in one hole.” The plaster jackets that were moved out this week contained skulls and other bones of dinosaurs that roamed the area during the Late Cretaceous period 75 million years ago, when a sea cut North America into western and eastern land masses. Among the fossils recovered are a near-complete skeleton of a *Gyposaurus*, described as a duck-billed dinosaur on steroids; an ankylosaur, an armored creature resembling a low tank with a club on the end of its tail; and a pterosaur that Titus described as similar to a “flying reptilian bat.” Also removed were fossils of turtles and a crocodile that thrived in the area when it was a steamy jungle and temperatures could reach 120 degrees. The *Gyposaurus*, identified as a new species of dinosaur two years ago, will be reconstructed and put on display at the new Utah Museum of Natural History being built at the University of Utah in Salt Lake City. Titus said the ankylosaur fossil is puzzling because it is more like those uncovered in Mongolia than specimens found further north. He said it may force paleontologists to rethink how dinosaurs migrated to the area. “We’ve always thought they crossed the land bridge from Asia into the interior [of

North America],” then went south, Titus said. “But there are no similar examples of [ankylosaurs] in Montana and Canada so maybe they followed the Pacific coast line south then migrated north. It’s a puzzle we’re slowly piecing together.”

Scott Sampson, research coordinator at the Utah Museum of Natural History and author of a new book, *Dinosaur Odyssey: Fossil threads in the Web of Life*, said the monument is truly a treasure. His book includes a chapter on the significance of discoveries on the monument. “It’s one of the greatest bone yards in the United States,” said Sampson, who also hosts the children’s television show *Dinosaur Train* on PBS. “The monument has opened a new window on the Late Cretaceous.” Ten years ago, he said, scientists thought fossils of species found in Canadian digs were different from those found in southern Utah because they lived at different times. But recent finds on the monument have shown that species in the north existed at the same time as those in the south.

This column was written near the end of 2009, a time when one expects to be informed by articles in magazines and TV programs touting the “best of ... for the year 2009.” So why not dinosaurs? *Popular Mechanics* magazine featured “The Top 8 Dinosaur Discoveries of 2009.” Cassie Rodenberg wrote the popular story for the November 16th issue (www.popularmechanics.com/science/earth/4336718.html), which includes some excellent illustrations suitable for classroom use. He writes that “Paleontologists have had a good year, bringing a slew of new dinosaurs to the books. We pored through the many finds to bring you the best horned, bird-footed, feathered and, of course, ferocious new dinosaurs unveiled this year.” His eight dinosaurs include the world’s smallest carnivore, *Hesperonyx elizabethae*, a four-and-a-half pounder about a foot and a half feet tall. Second, was *Raptorex kriegsteini*, the tiny dinosaur, 150 pounds and 10 feet long, that is related to *T. rex* and described elsewhere in this column. Third, is the bird-footed theropod dinosaur, *Limusaurus inextricabilis*, from the famous fossil beds of northeastern China. The animal had “a fully developed beak, a gimpy, reduced first finger and an enlarged second, indicating that *Limusaurus* was in a transition period from bird to dino-like digits.” Fourth, is a three-foot-long parrot-reptile from the Gobi desert in Mongolia. *Psittacosaurus gobiensis* resembles a less beaky version of modern-day macaws and is thought to be the first dinosaurs known to feed on nuts and seeds. Fifth, is the tank-like ankylosaur from Montana, *Tatankacephalus cooneyorum*, with its protective cover of hard plates and clubbed tail. Sixth, is another dinosaur from Mongolia’s Gobi desert, *Alioramus altai*, a tyrannosaur with slender teeth, long snout and eight 5-inch horns. Seventh, is another Chinese fossil, *Tianyulong confuciusi*, that possessed feathers and ate plants. And eighth is the

Giant Ostrich-Mimic, *Beishantong grandis*, that appears to be a bizarre mix of ostrich and dinosaur, thought to have weighed 1,400 pounds. Educators can find additional information about these animals by entering their names in Google search (www.google.com).

The article in the *Los Angeles Times* (www.latimes.com/news/nation-and-world/la-sci-mammoths20-2009nov20,0,3408140,print.story) by John Johnson, on November 20, 2009 about the reason for mammoth’s demise is another example of the long-term intense debate about the end of the Pleistocene megafaunal extinction. The report is about sediment beneath an Indiana lake that is providing clues for the discussion. One conclusion, according to the study, is clear: a meteor didn’t kill off the mammoths and other large plant eaters. About 15,000 years ago, North America was home to an astonishing number of large plant-eating mammals—giant sloths, mastodons, mammoths. A thousand years later, they were gone, wiped from the face of the Earth with sudden finality (except, of course, their bones). The search for the source of the story led me to a well-written press release from the University of Wisconsin, Madison, where the leader of the study, Jacqueline Gill, is a graduate student (www.news.wisc.edu/17396). Terry Devitt, the author of the press release, wrote that when populations crashed, emptying a land whose diversity of large animals equaled and sometimes surpassed Africa’s wildlife-rich Serengeti Plains of today, an entirely novel ecosystem emerged as broadleaved trees, once kept in check by huge numbers of big herbivores, claimed the landscape. Soon after, the accumulation of woody debris sparked a dramatic increase in the prevalence of wildfire, another key shaper of the landscapes. The press release led me to *Science* magazine, where the scientific study was actually published (www.sciencemag.org) on November 20, 2009 (vol. 326, no. 5956, pp. 1100–1103) by Jacquelyn Gill and others. They write that although the North American megafaunal extinctions and the formation of novel plant communities are well-known features of the last deglaciation, the causal relationships between these two phenomena are unclear. Using the dung fungus *Sporomiella* and other paleoecological proxies from Appleman Lake, Indiana and several New York sites, they established that the megafaunal decline closely preceded enhanced fire regimes and the development of plant communities that have no modern analogs. Megafaunal populations collapsed from 14,800 to 13,700 years ago, well before the final extinctions. Human impacts remain plausible, but the decline predates Younger Dryas cooling, and the extraterrestrial impact event proposed to have occurred 12,900 years ago came too late. In the same issue of *Science* (pp. 1072–1073), Christopher Johnson of James Cook University, Queensland, Australia gives his perspective on the study. He writes that by 10,000 years ago,

34 genera of mammals were gone, including ten species that weighed more than a ton. The power of the new study (by Gill) comes from the use of tiny organisms, fungal spores, to reconstruct the decline of the very biggest animals. Basically, lots of dung means lots of spores, which is an index of the biomass of large herbivores. He also asks, “what about people.” It has been long argued that Clovis people were specialized big mammal hunters who caused the megafaunal crash

within a few hundred years. “But the new data show that the megafaunal decline had begun more than a thousand years earlier. If people were responsible for the decline, they must have been pre-Clovis settlers. The existence of such people has been controversial.” The Johnson article also contains a well-drawn illustration of mastodons in their savanna-like habitat some 13,300 to 12,900 years ago, as well as two graphs supporting the conclusions of the paper.