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OTHER MEDIA REVIEWS

Paleontology and Evolution in the News

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Abstract This is a review of recent publications and journal articles about evolution and paleontology.

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Review

As usual, dinosaurs never seem to be out of favor with the public (nor with paleontologists), as exemplified by the number of popular articles appearing in newspapers and magazines. Taking that interest into account and providing an entertaining venue with educational overtones is probably the dream of many dinosaur lovers and entrepreneurs. "Jurassic Forest and Learning Centre," a new dinosaur-themed park located near Edmonton, Alberta, was reported opened by a number of Canadian news outlets (for example, www.fortsaskatchewanrecord.com). Located in a region known for its dinosaurs, this 40-acre enclosure contains 40 interactive robotic, life-sized, rubber-skinned dinosaurs, including, of course, *Tyrannosaurus rex* and *Albertosaurus*, as well as the plant-eaters *Stegosaurus* and *Triceratops*. Funded by a group of private investors, the facility took two years to complete and has hopes of attracting the general public as well as school groups. How well the interpretative information along the guided trails in the forest or at the education center is described could not be ascertained at this time. However, innovative teachers should be able to use the dinosaurs as the basis for teaching about the area's paleontological and geological history. The general manager, Greg Suess, has said that "We're not an amusement park. We're not trying to be a theme park. We want to combine a quality education experience with a very high-quality entertainment experience."

In the July, 2010, issue of *PLoS Pathogens*, volume 6, issue 7, pages 1–13 (http://www.plospathogens.org), Vladimir Belyi, Arnold J. Levine, and Anna Marie Skalka published "Unexpected Inheritance: Multiple Integrations of Ancient Bornavirus and Ebolavirus/Marburgvirus Sequence in Vertebrate Genomes." The researchers say that vertebrate genomes contain numerous copies of retroviral sequences acquired over the course of evolution. Reported in a number of newspapers and magazines, it is interesting to note what was chosen to be emphasized in their headlines. For example, The *Philadelphia Inquirer* headline states on July 30, 2010 (http://www.philly.com/inquirer) in an article by Tom Avril that: "Study of virus fossils offers clues to surviving infection," while the headline in *ScienceNow*, on July 29, 2010, by Jennifer Couzin-Frankel (http://news.sciencemag.org/sciencenow/2010/07/deadly-viruses-have-been-part-of.html) describes the results of the paper: that the researchers have found that viruses responsible for Ebola, Marburg hemorrhagic fever, and other deadly diseases have been incorporated in the genomes of certain animals for tens of millions of years, and these viruses have integrated themselves into the DNA of a wide range of animals. The study shows that humans and other vertebrate genomes (zebra fish, a squirrel, a bat, for example) contain ancient genetic sequences from two often deadly families of RNA

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viruses—*Filovirus* and *Bornavirus*—families not previously known to leave genetic material in vertebrate DNA. These RNA viruses can't easily convert their genetic material into DNA, a step that is required for insertion into an animal's genome. But the study shows that this has happened and suggests that it is more common than previously thought. Although the researchers don't know whether the inserted viral sequences have a function, "they suspect they are helpful to the animals—otherwise they wouldn't have endured through millions of years of evolution." The authors compared over 5,000 genes from all known non-retroviral families with single-stranded RNA genomes against the genomes of 48 vertebrate species, uncovering 80 separate viral sequence integrations in 19 different vertebrate species. While it is not known how genetic material from RNA viruses could have entered host DNA, the study shows that some integrations took place as long as 40 million years ago. The authors provided a summary of their work: "Vertebrate genomes contain numerous copies of retroviral sequences, acquired over the course of evolution. Until recently they were thought to be the only type of RNA viruses to be so represented…We compared…all known non-retroviruses...Surprisingly, almost all of the nearly 80 integrations indentified are related to only two viral families, the Ebola/Marburviruses and Bonaviruses, which are deadly pathogens that cause lethal hemorrhagic fevers and neurological disease, respectively. The conservation and expression of some of these endogenous sequences, and a potential correlation between their presence and a species' resistance to the diseases caused by the related viruses, suggest that they may afford an important selective advantage in these vertebrate populations."

A press release issued on September 1, 2010 from the University of Bristol (http://www.bristol.ac.uk/news/2010/7193.html) describes a paper written by university researchers J.C. Trevor, P.C.J. Donogue, and M.J. Benton, "Is evolutionary history rewritten in light of new fossil discoveries?" The press release states that "Paleontologists are forever claiming that their latest fossil discovery will 'rewrite evolutionary history.' Is this boasting or is our knowledge of evolution so feeble that it changes every time we find a new fossil?" Their analysis focused on studies of dinosaur and human evolution. They suggest that most fossil discoveries do not make a huge difference, which confirms our understanding of evolutionary history. They say that even though early human fossils are immensely rare, their discoveries don't change much. One of the authors, James Trevor, the leader of the study said: "Human fossils are very rare, and they are costly to recover because of the time involved and their remote locations. Scientists may be pushed by their sponsors, or by news reporters to exaggerate the importance of their new find and make claims that 'this new species completely changes our understanding. However, the story of dinosaur evolution is a bit more complicated because new fossils are being found in places never before known to fundamentally challenge existing ideas about dinosaur evolution." Their paper was published in the *Proceedings of the Royal Society B*, September 1, 2010, pages 1–6 (http://rspb.royalsocietypublishing.org/content/early/2010/08/31/rspb.2010.0663.full?sid=c5bebd4e-e6c3-4265-b7e7-021a26a). In their paper, they state that "Our study outlines a variety of tests that can be readily conducted to assess the robustness of phylogenetic trees to the continued discovery of taxa….Ultimately, our study indicates that the stability of taxonomic datasets should be assessed before embarking on macroevolutionary studies, or else researchers run the risk of conflating artefacts of incomplete taxonomic, stratigraphic, ecological or biogeographic sampling for evolutionary phenomena."

How much is an Egyptian whale fossil worth? Philip Gingerich of the University of Michigan discovered a new fossil of a whale in the Wadi Hitan in Egypt, also known as the Valley of Whales because of the numerous specimens that have been found there. Gingerich said it took about two-and-a-half years to get permission to remove the skeleton, an exceptional specimen of a 37 million-year-old whale, *Basilosaurus isis*. Although now desert, the area in Egypt where the specimens are found was covered by the Tethys Sea about 40 million years ago before it retreated eventually to the Mediterranean basin. The significance of the specimen is that it is the only complete specimen of this species of whale and provides evidence of how whales evolved from being land-based animals that went back to the sea. A key feature of the specimen is that it has tiny feet, human-sized, in a specimen that is about 50 feet long. It has taken Gingerich and his team about two years to reassemble the skeleton and return it to Egypt for a new museum, planned for the Valley of Whales. However, as reported in *BBC News Middle East* (http://bbc.co.uk/news/world-middle-east-10824132) written by Jon Leyne on July 30, 2010, the specimen has been the subject of a "bizarre" customs wrangle at the Cairo airport where it is stuck. The customs agents are demanding a $40,000 fee, an amount that has been mysteriously determined. The Egyptian authorities importing the fossil are refusing to pay, while a senior official from the ministry of tourism has warned that the issue needs to be resolved speedily; otherwise, it could cause a "big scandal" for Egypt. Gingerich joked that it took two-and-a-half years to be allowed to export the fossil to the United States, and it could take another two-and-a-half years to get it back. At the time of this writing, there has been no resolution.

A new crocodilian discovered in southwestern Tanzania has altered a long-standing view of the group's features.

Found, excavated, and described by a team led by Patrick M. O'Connor of Ohio University and published in *Nature*, volume 466, number 5, August 2010 (http://www.nature.com) "The evolution of mammal-like crocodyliforms in the Cretaceous Period of Gondwana," the paper describes a new genus and species, *Pakasuchus kapilimai*, the size of a cat that contains an unusually diverse set of teeth. Numerous popular outlets describe the animal to varying degrees, many of which accompany the text with an illustration of the animal leaping in the air to snare a dragonfly. Perhaps the outlet of most value to educators is the article written by Ker Than in *National Geographic News* on August 4, 2010 (http://news.nationalgeographic.com/news/2010/08/100804-new-crocodile-fossil-pakasuchus-nature-science-mammal-teeth/), "Fossil 'Cat Crocodile' Had Mammal-like Teeth." Not only does it contain the illustration mentioned above but it also posts an over four-minute narrated video (with a ubiquitous, but brief advertisement) of the team removing the specimen, excavating it from its matrix, with a segment devoted to it unique set of teeth. Segments of this video can also be seen on YouTube (www.youtube.com). Be that as it may, the video, the illustrations in the scientific paper, and especially the chart showing the phylogenetic relationships of the new form within the crocodyliforms can be readily used for a classroom lesson. Besides its size (its skull can easily fit in the palm of a human hand), the most striking feature of the new crocodile is that it contains mammal-like teeth. With its canines, premolars, and molars, *P. kapilimai* could bite and chew its food using the sharp incisors in the front of its mouth for tearing food and the interlocking upper and lower molars at the back of the jaw for grinding the food. Modern crocodiles have only conical teeth of about equal size that are extremely sharp for grabbing and tearing. Modern crocodiles did not evolve from these notosuchians (southern crocodyliformes), which died out at the end of the Cretaceous around the same time that the dinosaurs disappeared. Was it a case of changing environments or new competitors or a combination of both? Two additional interesting aspects of the study were revealed: first, while these animals flourished in the southern supercontinent Gondwana, an area poor in mammal-like fossils, they filled ecological niches that were occupied by mammals in Laurasia (northern continent) at the time; and second, perhaps it would be a good idea if fossil collections of mammal teeth were reevaluated in light of these finding to ascertain that they are really crocodilian.

The cliffs of the Bay of Fundy have revealed numerous reptile fossils from the Pennsylvania Period, yet new discoveries seem to be made periodically. A team of British and Canadian researchers have discovered dozens of fossilized reptile footprints about 318 million years old from the cliffs on the New Brunswick side of the bay. These ancient trackways represent the earliest evidence of reptilian life living far from the sea on a continent during the time when the continents of the world were fused together as one supercontinent, Pangaea. At the time, the land mass that would become New Brunswick was near the equator enjoying a tropical climate. It is believed that the sandstone that contains the fossils was deposited on a river flood plain some 350 miles from the sea. Howard Falcon-Lang, the discoverer of the footprints, thinks that reptiles were about four inches long, perhaps gecko-like looking. The significance of these fossils is that they began colonizing inland environments, and key to this development was the development of eggs with hard shells that could be laid on land. This gave the creatures the freedom "to explore the heart of the Pangaean supercontinent." Recognizing the significance of the discovery, the news found its way into more than 150 outlets. CBC News (http://www.cbc.ca/technology/story/2010/07/30/reptile-footprints.html) reported the discovery on Friday, July 30, 2010 based on a paper in the journal *Palaeogeography, Palaeoclimatology, Palaeoecology* (volume 296, issue 1–2, pages 1–13). "About 400 million years ago, animals with backbones started to come on land, but these were-frog-like creatures. And amphibians such as frogs have to return to water in order to breed. They lay soft eggs that very easily dry out." Falcon-Lang said that there is evidence in New Brunswick of early reptiles living around a water hole in a very dry environment. "These early reptiles were moving into continental interiors, exploiting environments where animal life had not been before." A color image of a slab of rock covered with the footprints accompanies the report. The discoverer thinks that the footprints were made by an early reptile called *Hylonomus*, the skeletons of which have been found in adjacent Nova Scotia. He said, "It's a very key step in evolutionary history, because these tiny, small, scampering gecko-like reptiles were the ancestors of dinosaurs and the ancestors of you and me." A good illustration of the animal also appears in the article, similar in style to that supplied in the previous article about the Tanzanian crocodile.

The paleontological news from China on August 3, 2010 (http://news.xinhuanet.com/english2010/sci/2010-08/03/c_13427473.htm) is that the dinosaur museum in east China's Shandong Province has been confirmed by the Guinness World Records as the largest dinosaur museum in the world. And large it is. The Shangdong Tianyu Museum of Nature in Pingyi County has 301,389 square feet of exhibition space, displaying 1,106 dinosaur specimens and thousands of other fossils. Guinness' certificate claims that the specimens are almost complete skeletons and include 368 psittacosaurid specimens, 391 dromaeosaurid specimens, 255 *Anchiornis* specimens, 22 *Jeholosaurus* specimens, and 70 other rare dinosaurs and unnamed dinosaur fossils. Housed in the museum are tens of thousands of other fossils including bird

and fish specimens, the longest piece of silicified wood, and the biggest *Sinosauropteryx*. Museum field trip, anyone?

And there is just one additional dinosaur item, this one about names, which will perhaps disappoint diehard enthusiasts. A paper in the *Journal of Paleontology* by Jack Horner and John Scannella, of the Museum of the Rockies in Montana, explains that the three-horned dinosaur, *Triceratops*, never actually existed, but was, in fact, a juvenile version of another dinosaur, *Torosaurus*. As expected, it was reported in a large number of popular publications including the website of BBC World Service (http://www.bbc.co.uk/worldservice/news/2010/08/100803_triceratops_wt_sl.shtml) on August 3, 2010, which includes an illustration of the creature as well as an almost three-minute audio interview with Jack Horner explaining the results of his research. *Torosaurus* (*Triceratops*) lived between 72 and 65 million years ago. Although both have the typical three horns, they and the neck-frills differ in shape, a characteristic that the researchers say is the result of the difference in age. These features change shape as the dinosaur ages because when they are growing they are soft and spongy and don't harden until the animal matures.

A press release from the Imperial College of London on August 4, 2010 (http://www3.imperial.ac.uk) boasts that a unique blob-like creature that lived in the ocean approximately 425 million years ago is revealed in a 3D computer model in research published in the journal *Biology Letters*. The model is helping researchers to understand what primitive species on early Earth looked like and how they might have evolved into the types of creatures that are on Earth today. Named *Drakozoon*, the animal was found about six years ago in the Herefordshire Lagerstatte, one of England's richest occurrences of soft-bodied fossils, deposited during the Silurian Period, 444 to 416 million years ago. The researchers say that *Drakozoon* was an ocean-dwelling, cone-shaped, three-millimeter blob-like creature with a hood and probably had a leathery outer skin. It attached itself to hard surfaces and used filament-bearing tentacles to catch and eat organic particles. Protection from predators was enabled by pulling the hood down over its body. A 3D model is provided and Mark Sutton of the Imperial College, the lead author of the paper, says: "Exceedingly, our 3D model brings back to life a creature that until recently no one knew existed, and provides us with a window into the life of *Drakozoon*. We think this tiny blob of jelly survived by clinging onto rocks and hard shelled creatures, making a living by plucking microscopic morsels out of sea water. By looking at this primitive creature, we also get one tantalizing step closer to understanding what the earliest creatures on Earth looked like." Sutton and his co-authors' analysis of their 3D model led them to discover that *Drakozoon* had eight deep ridges on either side of its body suggesting to them that these ridges are genetic remnants from a time when *Drakozoon* had a body made of repeated units, supporting the theory of some scientists that the earliest creatures were made of repeated units. However, other researchers believe that the earliest creatures had bodies structured in a free-form way, similar, say, to slugs. The study also shows that *Drakozoon* was an early member of lophophorates, the group that brachiopods belong to. The researchers say it is rare to find ancient soft-bodied creatures intact because they normally decompose before they can be preserved in sediment. The soft-bodied *Drakozoon* was perfectly preserved because it lived in an area that was covered by volcanic ash following a volcanic eruption that instantly entombed it and other creatures living with it, keeping it intact for 420 million years. To create their 3D model, the researchers physically spliced the fossil into 200 pieces. These pieces were individually photographed, and the images were fed into a computer that generated the 3D model for analysis by the researchers.

"Our early ancestors may have looked decidedly ape-like, but they were already beginning to act like humans as much as 3.4 million years ago," writes Dick Ahlstrom of *The Irish Times* (http://www.irishtimes.com) on August 12, 2010. The use of stone tools by our ancestors began about 800,000 years earlier than previously thought, as recently as 3.4 million years ago. This article reports on new discoveries in the Afar region of Ethiopia that show *Australopithecus afarensis*, not a species of man but an early member of the human lineage, used tools. Until now, it was thought that only members of the genus *Homo* used tools. They found fossil bones at the site showing grooves cut into the bone—the result of meat being sliced away along with thin slivers of bone. The article is based on the paper published in *Nature* (http://www.nature.com) on August 12, 2010, volume 464, pages 857–860, "Evolution for stone-tool assisted consumption of animal tissue before 3.39 million years ago at Dikika, Ethiopia" by an international team including Sharron P. McPerron and Zeresenay Alemseged. The article reports on the discovery of stone tool cut marks on bones resulting from flesh removal and percussion marks from marrow access. The authors say, "The oldest direct evidence of stone tool manufacture comes from Goma (Ethiopia) and dates to between 2.6 and 2.5 million years (Myr) ago" and "at nearby Bouri site several cut-marked bones also show stone tool use approximately 2.5 Myr ago." The bones were collected from sediments that have been easily dated because they were sandwiched between tuff layers dated back to 3.42 and 3.24 million years ago. That, in addition to other geological evidence, indicates the sediments are more than 3.39 million years old. The article describes the methods used for examination of the bones, well-documented in the accompanying illustrations. Basically, the bone surfaces were examined under ×8–80 magnification. And although an

environmental scanning electron microscope (ESEM) was used to further document the marks, it was not needed for diagnoses and identification. The authors say there is no previous direct evidence that meat and marrow formed part of the diet of hominins at this early age. But they say it is not possible to show that stone tools were knapped for this purpose or to determine if naturally sharp-edged stones were collected and used. An accompanying article by David R. Braun in the same issue of *Nature*, page 828, "Australopithecine butchers," discusses the subject of tool use further by asking, "How far back in the human lineage does tool use extend?" But he also concludes that the meat and marrow of large animals must have been a valued resource because the authors conclude that the tool users incurred the cost of transporting stones six kilometers from where they occurred naturally to the site where the butchery took place. "Further costs that were associated with the consumption of carrion, and were apparently worth the risk, include exposure to parasites and competition with large carnivores...More surprises surely await us in the fossil-rich sedimentary basins of East Africa."

A striking image of a mammoth accompanies an article in the Mail OnLine by Fiona Macrae on August 18, 2010 (http://www.dailymail.co.uk/sciencetech/article-1303981/Did-global-warming-kill-woolly-mammoth.html), "Did global warming kill off the wooly mammoth? Scientists say it may have been climate change that wiped out the beasts." Many researchers say that humans were the cause of the extinction of the wooly mammoth and other large Pleistocene animals. It is true that people hunted them for their skins and meat but the new study shows that it may actually be climate change that killed them off. "Some 21,000 years ago, after the last Ice Age, warmer temperatures led to a loss of grassland over much of the Earth's surface as temperatures warmed and forests took over." As a result, the large grazing herbivores and the predators that fed off them disappeared. Brian Huntley, one of the authors of the study, said that "Wooly mammoths retreated to northern Siberia 14,000 years ago, whereas they had roamed and munched their way across many parts of Europe, including the U.K., for most of the previous 100,000 years." The research team looked at results for a vast geographic area including Eurasia (Europe and northern Asia) and the area of the Bering land bridge that connected Alaska and the Canadian Yukon to Siberia, Russia, at the height of the last glacial age. "They found the post-glacial warming of the planet coupled with an associated change to a moister climate with increased levels of carbon dioxide in the atmosphere, resulted in the proliferation of trees and the subsequent decline in grasslands…" Five species formerly present in Europe, northern Asia, Alaska, and Yukon that became globally extinct as grassland diminished are the wooly mammoth, cave lion, giant deer, wooly rhino, and cave bear. Of the species present during the Pleistocene, five species survived as the grassland diminished: brown bear, elk (moose), reindeer, saiga antelope, and musk ox. The study was published in *Quaternary Science Reviews* on May 31, 2010, volume 29, issues 19–20, pages 2604–2618, by an international team of researchers. Judy Allen of Durham University was the lead author of "Last Glacial Vegetation of Northern Eurasia." Although the popular article stressed the herbivorous fauna, the scientific paper is about how the vegetation pattern was determined. The last of the large vertebrate species that became extinct were either the result of human activities, or major environmental changes, or perhaps a combination of both. The article states that the nature of paleovegetation was inferred in the past primarily from pollen analytical data. But this approach has important limitations: (1) it is difficult to gain reliable estimates of the proportional cover of different plant functional types (e.g., trees vs. herbs), (2) estimates of paleovegetation productivity from pollen data, and (3) pollen data prior to the Holocene are sparse over large parts of northern Eurasia. The authors claim that dynamic vegetation models offer a means to simulate annual primary productivity, which gives insight to the vegetation patterns. Students interested in this approach and the modeling techniques that resulted in the 66 maps simulating annual net primary productivity should take a look at the appendix that accompanies the paper.

And near the base of life's evolutionary tree is the report from the *National Science Foundation* on August 17, 2010 (http://www.nsf.gov/news/news_summ.jsp?cntn_id=117502) that the discovery of the earliest animal life, a 650 million-year-old sponge-like creature, pushes back the fossil record. Princeton University geoscientists Adam Maloof and Catherine Rose happened upon the new fossils while working on a project focused on the severe ice age that marked the end of the Cryogenian period ("snowball Earth") 635 million years ago. The shelly fossils were found beneath the glacial deposits in South Australia, representing the earliest evidence of animal body form in the fossil record. These fossils are about 70 million years older than the previously known oldest fossils of reef-dwelling hard-bodied animals that lived around 550 million years ago. Included is an image showing the rocks that contain the stromatolite columns of bacterial mats and the intervening sponge fossils, along with several additional photographs of the site and the fossils. Maloof explains that their find provides the first direct evidence that animal life existed before—and probably survived—the severe "snowball Earth," the event that left the much of the globe covered in ice. "No one expected that we would find animals that lived before the ice age, and since animals probably did not evolve twice, we are

suddenly confronted with the question of how a relative of these reef-dwelling animals survived the 'snowball Earth.'" After recognizing that what they found were fossils Maloof, Rose and their collaborators teamed up with professionals at Situ Studio, a Brooklyn-based design and digital fabrication studio, to create three-dimensional digital models of two individual fossils that were embedded in the surrounding rock. "After considering a variety of alternatives, the scientists decided that the fossil organisms most closely resembled sponges—simple filter-feeding animals that extract food from water as it flows through specialized body chambers." To put this discovery in perspective, the previously oldest known fossil of hard-bodied animals were two reef-dwelling organisms that lived about 550 million years ago, *Namacalathus* discovered in 2000 and *Cloudinia* in 1972. In addition, the oldest undisputed Ediacaran animals, *Kimberella*, 555 million years old, are found in Australia and Russia. A number of illustrations in the Princeton University press release (http://www.princeton.edu/main/news/archive/S28/14/71M11/index.xml?section=opstories) includes a video showing the development of the three-dimensional digital model used to study the fossil. An explanation of how the model was created is also included, and students interested in this process should take a look at this explanation. The scientific paper these stories are based on was published in *Nature Geoscience*, volume 3, pages 653–657, August 17, 2010 (http://www.nature.com), "Possible animal-body fossils in pre-Marinoan limestone from South Africa." The authors state that the marine limestones in which the fossils were found were deposited in a tropical sea between two intervals of intense glaciation, one about 710 million years ago and the other about 635 million years ago.

An article in the *Vancouver Sun* on May 19, 2010 by Randy Boswell (http://www.vancouversun.com/health/Burgess+Shale+type+fossils+found+Africa/3046260/story.html) "Burgess-Shale-Type fossils found in Africa" describes the discovery of these fossil types by a team of scientists working in southeastern Morocco near the Atlas Mountains. According to the article, the significance of the discovery is that the Burgess Shale soft-bodied fauna was thought to have died out during the mid-Cambrian about 530 million years ago, but these new fossils are younger, from the Ordovician Period, about 480 million years old, which comprises a huge array of soft-bodied organisms including sponges, worms, mollusks, and other organisms, many typical of the Burgess Shale. Peter Van Roy, Yale University paleontologist and the lead author, said that these Moroccan fossils "indicate that Burgess-Shale-type creatures continued to play an important role in the diversity and ecological structure of deeper marine communities after the Middle Cambrian." Their discovery includes, so far, more than 1,500 individual specimens representing at least 50 different taxa. The newspaper article is based on a report in the journal *Nature*, volume 465, pages 215–218, on May 13, 2010. A Yale University press release issued May 12, 2010 quotes Derek Briggs of Yale University (http://opa.yale.edu), one of the eight international researchers who authored the scientific article, saying, "The early Ordovician was a critical moment when massive diversification takes off, but we were only seeing a small piece of the picture that was based almost exclusively on the shelly fossil record. Normal faunas are dominated by the soft-bodied organisms we knew were missing, so these exceptionally well-preserved fossils have filled in much of the missing picture." Previously, the loss of the Burgess Shale faunas was considered a major example of an extinction event. But given the discovery of this Ordovician fauna, it is now more likely that the probable so-called extinction is a reflection of the absence of preservation. So now it is clear that Burgess Shale biotas persisted after the Cambrian and are preserved where suitable facies occur. "The continued importance of Burgess Shale-type organisms through the Lower Palaeozoic reduces the distinction between Cambrian and subsequent faunas and warrants reinvestigation of the dramatic turnover between the Cambrian and Palaeozoic evolutionary faunas in the light of new discoveries of soft-bodied fossils."

And indirectly related to the Burgess Shale story is the notice that Harry Whittington, paleontologist, died on June 20, 2010 at the age of 94. Although he was exceptionally well-known in paleontological circles, his death was not mentioned to any great extent in the press. However, two laudatory obituaries appeared in British newspapers—*The Telegraph* (http://www.telegraph.co.uk/news/obituaries/science-obituaries/7933261/Professor-Harry-Whittington.html) and *The Guardian* (http://www.guardian.co.uk/science/2010/jul/08/harry-whittington-obituary). *The Telegraph* states that Whittington "was the former Woodwardian Professor of Geology at Cambridge and the world's leading authority on fossil trilobites; in later life his painstaking research revealed the 'Cambrian explosion.'" His work on trilobites was enhanced by his ability to extract fossils from their limestone rock matrix. In Virginia, he found that the fossils were silicified, while placing the limestone blocks in hydrochloric acid removed the limestone, leaving only fossils with all their anatomical details intact. It was as if they had gone to the beach and found shells there washed up on the strand. Trilobites, arthropods distantly related to horseshoe crabs and other crustaceans, had a hard carapace and lived from the Cambrian period, beginning 542 million years ago until they died out in the Permian period some 300 million years later—leaving in the geologic record some 20,000 species ranging in size from a millimeter to nearly two feet. The specimens retrieved from their acid bath allowed Whittington to discover how they grew from larva to maturity

during successive molts and how they moved and articulated their bodies. Later in his career, he studied Burgess Shale fossils, Middle Cambrian, 505 million years old, that were originally discovered by C.D. Walcott in British Columbia, Canada, in 1909, during the building of a railroad. Walcott originally thought of these unusual flattened animal remains as familiar animal types. Whittington and his assistants studied the collection at the Sedgwick Museum of Geology at Cambridge and "they patiently reconstructed the fossils in three-dimensional form, revealing a weird bestiary so different from anything now living that 15 to 20 organisms might rank as separate trunks of the evolutionary tree." In 1989, Stephen Jay Gould wrote a very popular book, *Wonderful Life: The Burgess Shale and the Nature of History.* Gould wrote that Whittington's description of the Burgess Shale was accompanied by "some of the most elegant technical work ever accomplished in paleontology." Whittington's career took him to Yale University in 1938 and then to Burma and China during World War II, then back to England after the war, followed in 1949 by a 17-year-long career at Harvard University. In 1966, he returned to Cambridge and, although eventually retiring in 1983, he continued to publish; of the 200 papers he wrote, 50 were published after his retirement, the last of which was published in 2009. As one might suspect, he was awarded many honors during his lifetime. Richard Fortey wrote in "Harry Whittington Obituary: Paleontologist who advanced knowledge of the origins of animal diversity" in *The Guardian* (http://guardian.co.uk/science/ on July 8, 2010) that "His death at the age of 94 marks the end of a heroic era for paleontology, when a single individual working patiently with a pin under the microscope could make discoveries as far-reaching in their way as those revealed by atom smashers." Fortey's obituary of Whittington relates the same general account of Whittington's life as in the other article mentioned above. He explains that Whittington's decision to study Burgess Shale fossils was a logical progression from trilobites, although while the shells contained details of the carapace structure, they lacked the preservation of soft anatomical parts. The Burgess Shale included trilobites in which they and the other preserved animals had exceptionally preserved soft body parts. His studies and those by his students showed that the Burgess Shale had an "astonishing array of life which seemed to have exploded suddenly into an unsuspected profusion." Those studies became famous as a result of Gould's book mentioned above. "Although there were some who felt Gould had cashed in on decades of hard labor by Harry and his colleagues, Gould was wholehearted in his admiration for the patient paleontologist…In fact, Harry had already been retired for five years when the brouhaha erupted, and took it all with self-deprecating humor. It made not a jot of difference to his routine…" Richard Fortey is a well-known geologist and science writer who studied at the University of Cambridge and had a long career as a paleontologist at the Natural History Museum in London, where his paleontological studies included trilobites and arthropod evolution. Among his many publications are *Trilobite!: Eyewitness to Evolution* (2000) and *Earth: An Intimate History* (2002). You can also watch him on YouTube (http://www.youtube.com/) describing his favorite fossil and how he obtained it (obviously, a trilobite). Teachers can capture YouTube videos, and there are many that are paleontologically oriented, although it would take some effort to select those for suitable classroom presentations or assignments.

"Central Park in New York Could Support 100 Big Dinosaurs" is the headline of an article in *DiscoveryNews* (http://news.discovery.com/dinosaurs/central-park-in-new-york-could-support-100-big-dinosaurs.html) by Jennifer Viegas, on August 16, 2010. She says that if dinosaurs were alive today, up to 100 huge individuals could enjoy a fairly comfortable existence in a space the size of New York's Central Park, which contains 840 acres in about 1.32 square miles. A study made by James Farlow, Sam Coroian, and John Foster of Indiana–Purdue University determined that a square kilometer of land could support "an upper limit of a few hundred animals across all taxa and size classes, and up to a few tens of individuals of large subadults and adults." The article held particular interest for me because I enjoy giving a program about what the dinosaurs ate in Central Park. The park contains a variety of habitats, as well as a great variety of trees and shrubs and other plants, both native and introduced, many of whose ancestors lived during the Mesozoic era. By making the connection between the herbivorous dinosaurs and what they ate, teachers can introduce many aspects of paleontology to students, including dinosaur evolution, dinosaur dentition, paleoecology, and plant evolution. Bringing images of the dinosaurs to the park field trip and relating them to the plants that the students see is an excellent out-of-doors and learning experience. No great park near your school? Perhaps there is a botanical garden, or if that is not possible, a local commercial garden center. Being interested in all things Central Park, I retrieved the research paper the above news article was based on from *Historical Biology*, volume 22, 1–27, "Giants on the landscape: modelling the abundance of megaherbivorous dinosaurs of the Morrison Formation (Late Jurassic, western USA)" (http://www.informaworld.com). A search of the pdf file revealed no reference to Central Park. The paper is basically about trying to figure out how many megaherbivorous dinosaurs one could have encountered per unit area on the Morrison landscape at any given time. The authors do feel that the attempt "is an example of attempting to solve an equation with too many unknowns." But they tried to make the calculations by using a plausible range of values or the relevant parameters. Their prediction model estimates the maximum plausible dinosaur

abundances based on the trophic resources rather than predation or other ecological factors. Within these considerations, the maximum average standing population density of the Morrison megaherbivorous dinosaurs could have been on the order of a few tens of individuals of all sizes/ages and a few large adult and subadult individuals of large size per square kilometer. However, "If dinosaurian metabolisable energy requirements had been closer to expectations for gigantic varanid lizards, the upper limit of dinosaur population sizes could have been higher, a few hundred individuals of all sizes and a few tens of individuals of large size, per square kilometer." So the author of the popular article in *DiscoveryNews* simply applied the conclusions of the research paper to a place of known size, and it is only the size that is taken into account here. The environment of the Morrison Formation was very different from Central Park today.