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OTHER MEDIA REVIEW

Paleontology and Evolution in the News

Sidney Horenstein

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

Keywords Arsenic · Gammoproteobacteria · Extinctions · "Great Dying" · Permian · Early European farmers · Baby dinosaur footprints · Cambrian explosion · Dinosaur embryos · Polar bears · Pterosaurs · Insects and climate warming

Review

While I was completing this column, National Aeronautics and Space Administration (NASA) Science News (http://www.nasa.gov/topics/universe/features/astrobiology_toxic_chemical.html) released an article on December 2, 2010, "Discovery of Arsenic Bug Expands Definition of Life." By the next day, Google (http://www.google.com) reported that 1,492 related articles were posted. What was all the excitement about? In NASA's words, "NASA-supported researchers have discovered the first known organisms on Earth able to thrive and reproduce using the toxic chemical arsenic. The microorganism, which lives in California's Mono Lake, substitutes arsenic for phosphorous in the backbone of its DNA and other cellular components." Edward Weiler, NASA's associate administrator for the Science Mission Directorate said that "the definition of life has just been expanded." He also said that "as we pursue our efforts to seek signs of life on the solar system, we have to think more broadly, more diversely, and consider life as we do not know it." Thus, the question: are there other forms of life in the universe that scientists never discovered simply because they were looking for life forms that resemble those which are found most commonly on Earth? Felisa Wolfe-Simon, a NASA scientist, and Ariel Anbar, a researcher at Arizona State University, announced that their research team made the ground-breaking discovery. The newly discovered microbe, strain GFAJ-1, is a member of a common group of bacteria, the gammoproteobacteria. In the laboratory, the researchers successfully grew microbes from the lake on a diet that was very lean in phosphorus but included generous helpings of arsenic. "When the researchers removed the phosphorous and replaced it with arsenic the microbes continued to grow." The web site also contains a 2-minute 23-second video "Tree of Life," which explains in part DNA structure. Prior to the actual news conference, NASA announced that it would reveal a new discovery which would have an impact upon the search for extraterrestrial life. Enticed, the media wanted to know more immediately—an interest that can be seen in the number of articles that have been noted by *Google News*. Well, we know now that NASA scientists did find alien life—not in space but in California. As noted in several blogs, science fiction buffs consider the announcement a complete dud (http://blogs.forbes.com/johnfarrell/2010/12/03/arsenic-aliens-not-quite-what-we-expected/?boxes=Homepagechannels). But for the scientific community, it was a spectacular discovery. As most biology and paleontology students know, all DNA on Earth is basically the same, and by rearranging the components of DNA of yeast you can, for example, convert them into that of mice or even lions. So the scientists found a new DNA that does not incorporate the usual six elements: carbon, hydrogen, oxygen, nitrogen, phosphorous, and sulfur. You

S. Horenstein (✉)
American Museum of Natural History,
Central Park West at 79th Street,
New York, NY 10024, USA
e-mail: horenst@amnh.org

can read and listen to an interview on National Public Radio, during which Ira Flatow interviews Dr. Felisa Wolfe-Simon, the lead scientist, discussing her work (http://www.npr.org/2010/12/03/131785452/Arsenic-Eating-Bacteria-Challenge-View-Of-How-Life-Works). The arsenic in Mono Lake comes from runoff from the Sierra Nevada Mountains, loading the lake with high concentrations of arsenic that the bacteria uses to replace the phosphorous atom in the DNA with arsenic. It has been suggested that this discovery raises the possibility that there is an alternate form of life that may exist on Earth and possibly other planets. The real lesson here is that extreme environments that are too toxic, thus usually unsuitable for life, may harbor forms of life that take advantage of the unusual situations. Perhaps the discovery may not be so unusual when we take into account the possibility that our own DNA may have first originated on the deep sea floor near volcanoes emitting a noxious brew of toxic chemicals. I randomly looked at a number of stories reported in the press just to get a sense of how the story played out around the world. Here are a few. In India (http://www.deccanchronicle.com/hyderabad/new-bacteria-can-clean-patancheru-783), the *Deccan Chronicle* speculates whether the newly discovered bacterium can solve the problem of arsenic poisoning in pollution hotspots, including the town of Patancheru, which is so polluted with arsenic and other toxic chemicals that it is considered not livable even though there is a substantial population. "The discovery of the arsenic-eating bacterium has been hailed by scientists in Hyderabad, and they hope the problem of ground water and soil pollution by arsenic can be solved in a 'natural way.'" In a story by Alok Jha in the *Guardian* on December 2, 2010, (http://www.guardian.co.uk/science/2010/dec/02/nasa-bacteria-arsenic-phosphorus) he states that "The reality is nowhere near as epoch-making but it is a fascinating discovery that if confirmed will force a rethink on Earth and have implications for how we identify it on other planets." Professor Paul Davies, a cosmologist at Arizona State University and an author of the scientific paper said, "this organism has dual capability—it can grow with either phosphorous or arsenic. That makes it very peculiar, though it falls short of being some form of truly 'alien' life belonging to a different tree of life with a separate origin." In the end, all the stories are dependent on both the NASA news conference and the scientific paper published first online on the website of the magazine *Science* (http://www.scienceexpress.org/2December2010/Page3/10.1126/science.1197258) published December 2, 2010. The paper basically describes the chemistry and techniques used to examine the bacterium in question. Finally, included within the media articles are numerous items from the blogosphere, many of which relate the information discussed above, but a few are critical of the science and the conclusions of the study. No doubt there will be much scrutiny of the techniques and conclusions of the report. I will follow this story and report in the next column on any significant updates.

Now if interest in the subject of extinction by the news media is any indication of the interest and concern among governments and citizens-at-large, then the response to the report that will be published in the magazine *Science* (http://www.sciencemag.org/) indicates that the concern is real. Numerous newspapers, magazines, blogs, and TV stations of all types from around the world reported on the preprint of the article that things are not good for the world's vertebrates, with a fifth of them at risk of extinction. An in-depth report in the *Wall Street Journal* (http://online.wsj.com/article/SB10001424052702303891804575576533344391798.html), "A War Against Extinction" by Gautam Naik on October 28, 2010, neatly summarizes the situation. While the state of affairs looks dire, there are some upbeat instances for mammals, birds, and amphibians where the "loss would have been 20% greater without such conservation efforts as the creation of animal sanctuaries, habitat protection, creative-breeding programs and the crackdown of poachers." The report states that the number of white rhinos in South Africa has risen from 50 animals to 17,000 in the past century as a result of habitat protection. However, the status of other groups is not too positive: for 25,000 vertebrates in the study, 41% of amphibians are threatened, 25% of mammals, 22% of reptiles, 13% of birds, 33% of cartilaginous fish such as sharks, and 15% of bony fish such as southern bluefin tuna. The analysis agrees with and adds documentation to the conclusion of many researchers that we are in the midst of an event termed "the sixth extinction." It is the sixth because paleontological studies of the geologic past have shown that the earth has seen five major extinction episodes. This present-day extinction is directly blamed on human activities such as increases in agriculture, logging, habitat destruction, hunting and the exploitation of natural resources in developing countries that are home to hundreds of threatened species. The latest study of vertebrates was based on data collected for the 25,000 species listed in the International Union for the Conservation of Nature Red List of Threatened Species. "Invertebrates face similar trends, with 33% of reef-building corals, 32% of freshwater crayfish and 13% of dragonflies threatened." The problem, of course, is that in general, because species are linked to each other intricately, an extinction will set in motion a domino effect of further species losses and changes in the environment.

A press release from *University of Cincinnati News* by Greg Hunt on October 22, 2010 describes "Cincinnati's Algeo Tracks Evidence of 'The Great Dying'" (http://www.uc.edu/news/NR.aspx?id=12619). It reports that geologist Thomas J. Algeo will discuss his work at the meeting of the Geological Society of America that was scheduled for October 31 to November 3, 2010 in Denver. "More than

251 million years ago, at the end of the Permian period, Earth almost became a lifeless planet. Around 90 percent of all living species disappeared then, in what scientists call The Great Dying." This extinction event is one of the five major extinctions that have taken place on Earth in the geologic past. Algeo's work involves investigating the chemical evidence buried in the rocks formed during the Permian extinction. He describes the Earth as a devastated landscape, barren of vegetation, scarred by erosion from showers of acid rain, huge "dead zones" in the oceans, and runaway greenhouse gasses leading to sizzling temperatures. He said that the Permian extinction is still not fully understood, but it was not caused by a large meteoroid striking the earth as happened 65 million years ago at the end of the Cretaceous period, causing the extinction of the dinosaurs. The evidence Algeo et al. are looking at points to massive volcanism in Siberia. They report that a large portion of western Siberia reveals volcanic deposits five kilometers thick, covering an area equal to the size of the continental United States. He claims that the process that killed the dinosaurs is similar to the cause of the Permian extinction in the following way: the Cretaceous bolide was lethal because it vaporized sulfur-rich sediments that produced extremely acidic rainfall. The massive Permian basaltic lava flows penetrated a large coal deposit, releasing large amounts of methane, a gas that is 30 times more effective as a greenhouse gas than carbon dioxide. A lot of the evidence ended up being washed into the ocean, and Algeo et al. are looking at oceanic deposits found in Canada, China, Vietnam, Pakistan, India, Spitsbergen, and Greenland.

Professor Alan Cooper, Director of the Australian Centre for Ancient DNA, and a team of international researchers announced that they have "resolved the longstanding issue of the origins of the people who introduced farming to Europe some 8,000 years ago" in a University of Adelaide Media Release on November 10, 2010 (http://www.adelaide.edu.au/news/news42161.html), "DNA reveals origins of first Europeans farmers. The press release describes that "a detailed genetic study of one of the first farming communities in Europe, from central Germany, reveals marked similarities with populations living in the Ancient Near East (modern-day Turkey, Iraq, and other countries) rather than those from Europe." Previously, it was thought that the first European farmers arose from existing populations of hunter-gatherers who had either rapidly learned to farm or had interbred with the invaders. But the evidence now shows that the first farmers were invaders with a revolutionary new idea. Dr. Wolfgang Haak the lead author of the scientific publication of the team's work published in *PLoS Biology*, said "We've been able to apply new high-precision ancient DNA methods to create a detailed genetic picture of this ancient farming population, and reveal that it was radically different to the nomadic populations already present in Europe. We have also been able to use genetic signatures to identify a potential route from the Near East and Anatolia, where farming evolved around 11,000 years ago, via south-eastern Europe and the Carpathian Basin (today's Hungary) into Central Europe." ("Ancient DNA from European Farmer's Reveals Their Near Eastern Affinities," (http://www.plosbiology.org/article/info%3Adoi%2F10.1371%2Fjournal.pbio.1000536). Here is a part of the paper's abstract: "In Europe, the Neolithic transition (8,000–4,000 B.C.) from hunting and gathering to agricultural communities was one of the most important demographic events since the initial peopling of Europe by anatomically modern humans in the Upper Paleolithic (40,000 B.C.). However, the nature and speed of this transition is a matter of continuing scientific debate in archeology, anthropology, and human population genetics. To date, inferences about the genetic makeup of past populations have mostly been drawn from studies of modern-day Eurasian populations, but increasingly ancient DNA studies offer a direct view of the genetic past. We genetically characterized a population of the earliest farming culture in Central Europe, the Linear Pottery Culture (LBK; 5,500–4,900 calibrated B.C.) and used comprehensive phylogeographic and population genetic analyses to locate its origins within the broader Eurasian region, and to trace potential dispersal routes into Europe."

A bunch of sandstone boulders have been sitting along the side of the Alameda Parkway in Colorado since that road was constructed in the 1930s. Although the boulders were suspected of containing fossilized dinosaur bones, they were not looked at all these years—that is until five years ago—when they were brought back to the Morrison Natural History Museum, where they were examined, leading to the discovery of repetitive shapes in one of the 150 million-year-old sandstone blocks. Emile Hallez Williams reports in the *Columbine Courier* (of South Jackson County, Colorado) on November 4, 2010 the story, "A Big Find: World's Smallest longneck dinosaur tracks discovered in Morrison" (http://www.columbinecourier.com/content/big-find). "During the collection we began to find fossil footprints on these blocks," said museum director Matt Mossbrucher, noting that adult-size prints were more readily obvious. "Bones and tracks in the same beds are really unusual. Once we were certain of what we were looking at with the big tracks, we started to find smaller and smaller tracks." How small? About the size of a soft ball, and they were identified as belonging to an Apatosaur about 6 feet long and weighing about 40 pounds. A fully grown adult of the species *Apatosaurus ajax* could weigh as much as 80,000 pounds and grow to a length of 100 feet. Apparently, identification of the tracks was easy because of the distinctive squared-off claw found only in *Apatosaurus* that is adapted for digging. Information regarding the tracks was presented at the 2010 Geologic

Society of America's Annual Meeting & Exposition in Denver on Monday, November 1. The GSA's press release about the discovery added some additional information about the tracks and *Apatosaurus* (http://www.geosociety.org/news/pr/10-63.htm). In 1877, Arthur Lake uncovered the very first apatosaurs—three skeletons of the 30-ton giant that was named *Apatoaurus ajax*. Later discoveries in Wyoming and Utah proved that sauropods were among the dominant giant herbivores in the late Jurassic. About the tracks: "The distance between each step is two-times wider than what we observe in walking tracks, indicating that the animal was in a slow speed run...In the end, we might have a baby sauropod that is running like a Basilisk lizard, a modern lizard that is mostly a quadruped but when spooked it runs on its hind legs...Although collected five years ago, these tracks were a part of a backlog of new discoveries made by the Museum staff. The continuous stream of discoveries coming from the Morrison Museum demonstrates that an energetic small natural history institution can make unique contributions to science and science education." The website of the Morrison Natural History Museum is http://www.mnhm.org/.

All paleontology students have learned that "beginning about 542 million years ago, a profusion of animals with shells and skeletons began to appear in the fossil record. So many life forms appeared during the time it is often referred to as the 'Cambrian Explosion,'" according to a press release from the Office of Public Affairs, U.C. Santa Barbara, released November 9, 2010 in "New Timeline for Appearance of Skeletal Animals in Fossil Record Developed by UCSB Researchers" (http://www.ia.ucsb.edu/pa/display.aspx?pkey=2364). One of the coauthors of the report, Susannah Porter, said "We found that with improved dating and correlation of rock sequences, the short burst of appearances goes away. Instead, appearances of the earliest skeleton-forming animals were drawn out over more than 20 million years." It appears "that skeletal animals became more diverse much earlier than was thought, with nearly half of the animal genera in the dataset appearing in the first 10 million years of the Cambrian Period" added John Moore, another coauthor. The lead author, Adam Maloof of Princeton University, said that "The Cambrian diversification of animals was long thought to have begun with an explosive phase at the start of the Tommotian Stage, 17 million years above the base of the Cambrian. To test this idea, we matched earliest Cambrian records of carbon isotope variability from Siberia, Mongolia, and China with a Moroccan record constrained by five radiometric ages from interbedded volcanic ashes. This time interval ranged from 542 to 520 million years ago." Porter explained that this approach avoids the circularity associated with using fossils to correlate rocks, then using those correlations to infer biological patterns. The results indicate that early skeletal animals appeared during a 20 million-year interval of rising sea levels and increasingly oxidizing conditions at the sediment-water interface in shallow water environments. The actual paper, "The earliest Cambrian record of animals and ocean geothermal changes," was published in the *Geological Society of America Bulletin* (http://gsabulletin.gsapubs.org/content/122/11-12/1731). In his book *On the Origin of Species*, Charles Darwin suggested that one of the greatest challenges to his ideas was the "sudden appearance of groups of Allied Species in the lowest known fossiliferous strata" (Darwin 1859, p. 306). He wrote "If my theory be true, it is indisputable that before the lowest Silurian stratum was deposited, long periods elapsed, as long as, or probably far longer than, the whole interval from the Silurian age to the present day; and that during these vast, yet quite unknown, periods of time, the world swarmed with living creatures… To the question why we do not find records of these vast primordial periods, I can give no satisfactory answer (Darwin 1859, p. 307)." The dilemma Darwin faced was that if all life descended via gradual modification from a single common ancestor, then the complexity and diversity of fossils found in Cambrian strata (at that time referred to the lower part of the Silurian) demanded a long interval of evolution prior to the beginning of the Cambrian. During Darwin's time, there was no evidence of this life, and all that he could offer as explanation was the incompleteness of the geological record. The interval of time during which the ancestors to trilobites, brachiopods, molluscs, and other Lower Cambrian taxa evolved is not preserved in the rock record. In his chapter on the imperfection of the geological record, Darwin alludes in passing to a different explanation for the supposed sudden appearance of animals in the lowest fossiliferous strata. He writes "[w]e should not forget that only a small portion of the world is known with accuracy" (Darwin 1859, p. 307). It is this explanation—the incompleteness of our knowledge—that has turned out to be closer to the truth. The problem of missing fossil ancestors was solved by the discovery of the Precambrian fossil record. The problem that nearly all the animal phyla appear in the Lower Cambrian with no evidence of intermediate taxa was solved by the recognition that most Lower Cambrian fossils represent stem groups of living phyla. And the problem of the explosive diversification of animals at the start of the Tommotian was solved by improved correlation and radiometric dating of Lower Cambrian sequences—to which we contribute here—showing that this diversification was drawn out over more than 20 million years. For students and classroom use, there are a number of useful figures including: tentative paleogeographic reconstruction for circa 525 million years ago, carbon isotopes and fossil ranges plotted against age, and timing of animal appearances in the earliest Cambrian.

A broadcast on CBS4 Denver reports on the mastodon and mammoth fossils uncovered in Snowmass, Colorado, altitude 8,874 feet, that was shown to the public at the Denver Museum of Nature and Science on November 18, 2010. The fossils were discovered accidently at Ziegler Reservoir near the village and include eight to ten American mastodons, four Columbian mammoths, two ice age deer, four Ice Age bison, one Jefferson's ground sloth, one tiger salamander, distinctly chewed wood indicative of beavers, insects including iridescent beetles, snails, ostracods, and large quantities of wood, seed and cones. Daniel Fisher, a mastodon expert from the University of Michigan said "There have been suggestions that high-altitude environments might have harbored different communities...but since fossils representing them are so rarely found, no one has known for sure." Initial radiocarbon dating indicates that "the Ziegler Reservoir site is more than 43,500 years old but can be as old as 130,000 years." The site was shut down for winter on November 2, 2010.

The People's Daily Online (http://english.peopledaily.com.cn/90001/90782/7210864.html) on November 25, 2010 reported the Chinese State Council released the following Fossil Protection Regulations: "All units and individuals are prohibited to transfer, exchange or give away fossils under state protection to foreigners or foreign organizations...A fossil under state regulation refers to fossils with important scientific value or rare fossils, including type specimens of ancient biological fossils that have been given a name as well as complete or relatively complete preserved ancient vertebrate body fossils." To protect fossils specimens, China has established five dinosaur, bird and ichthyosaur fossil museums in Lufeng of Yunnan, Zhucheng of Shandong, Lingwu of Ningxia, Sihetun of Liaoning, Chaoyang of Liaoning and Guanling of Guizhou, as well as 17 geological parks in cities such as Benxi of Liaoning. Fossils that have not been formally identified are not allowed to be taken abroad, and transportation of fossils to foreign countries requires approval from the Ministry of Land Resources even if they may be for international scientific cooperation or overseas exhibitions aimed at promoting scientific and cultural exchanges, according to the Fossil Protection Regulations jointly released by the Legislative Affairs Office of the State Council and the Ministry of Land and Resources on November 24. Under these new regulations, organizations and individuals are not allowed to sell fossils, and state-owned entities are not allowed to sell, exchange or give away fossils to private entities or individuals. A related article in the *People's Daily Online*, November 10, 2010 (http://english.peopledaily.com.cn/90001/90782/7194876.html#), "Canada returns prehistoric fossils to China," contains an image of a *Sinohydrosaurus* fossil that was smuggled out of China into Canada seven years ago and returned to China. It was part of a collection of 35 fossils dating back 130 million years that also included *Lycoptera* fish, plant, and insect fossils all originating from Liaoning Province in northeast China. The fossils were seized by the Canada Border Services Agency in 2003 and stored in the Canadian Museum of Nature in Ottawa. "The priceless prehistoric fossils were returned by the Canadian government at a ceremony at the museum, marking the country's first return of cultural property to China. The fossils were repatriated in accordance with the 1970 UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property and the Federal Court of Canada." In a speech, the Chinese Embassy Charge d'Affaires to Canada Xu Bu said: "Fossils are China's much cherished non-renewable cultural heritage. These 35 fossil pieces are of great archeological and scientific value. We are very happy to see them return to where they belong."

On the other hand, on November 24, 2010 Cincinnati.com posted a story that was written by Lauren Bishop about a new exhibit showcasing the discovery of an entirely new species of dinosaur that made its world premier at the Cincinnati Museum Center. "The 3,000-square-foot exhibit, Dinosaur Bones: Titans of the Ruyang, includes 12 rare, real dinosaur fossils found in China, three moving, roaring animatronic dinosaurs...The exhibit also shares the human, economic and cultural stories of the Chinese village where the bones were found." The late Cretaceous fossils were found in 2006 in Shaping, China, a small rural village in Ruyang County in Henan Province. Two sauropods, *Ruyangosaurus giganteus* and *Huanghetitan ruyangensis* are among the largest, widest and heaviest dinosaurs found in Asia. *R. giganteus* is 98 feet long with neck heights reaching 30 feet.

"A Canadian-led team of scientists that probed the tiny, petrified skeletons inside a pair of 190-million-year-old dinosaur eggs has shed new light on the evolutionary origins of such later reptilian giants such as *Diplodocus*." Randy Boswell writes the story about this endeavor in the *Vancouver Sun* for November 14, 2010, "Dino eggs crack open mysteries of creatures' evolutionary path" (http://www.vancouversun.com/technology/Dino+eggs+crack+open+mysteries+creatures+evolutionary+path/3824603/story.html), which includes a compelling drawing of the hatchling. The eggs, originally found in South Africa in 1976, are said to contain the oldest embryos ever found from a land-dwelling vertebrate. Described as remarkably preserved, the eggs contained the 20 centimeter-long fossils of two unborn members of a species of *Massospondylus*, a 190 million-year-old Jurassic-age member of an early, protosauropod group of dinosaurs that were ancestors of sauropods, the large, four-legged dinosaurs such as *Diplodocus*. Modern imaging techniques and high-tech tools that were not available when the eggs were originally found have allowed the research

team lead by University of Toronto paleontologist Robert Reisz to successfully reconstruct the fossilized bones. David Evans and Diane Scott, also of the University, together with Hans-Dieter Sues of the Washington, D.C.-based National Museum of Natural History, co-authored the scientific report that will appear in the Society's *Journal of Vertebrate Paloentology*, volume 30, number 6 as "Embryonic skeletal anatomy of the sauropodomorph dinosaur *Massospondylus* from the Lower Jurassic of South Africa." Much of the information in the article describing the fossils appears in a press release from the Society of Vertebrate Paleontology (http://www.vertpaleo.org/news/permalinks/2010/11/12/PRESS-RELEASE---Oldest-dinosaur-embryos-give-insights-into-infancy-and-growth/). Most of the bones of the embryo were ossified, revealing that they were close to hatching. After the bones were exposed, it was obvious that the future hatchlings would have been oddly proportioned and would have looked very different than the adults. The baby animals would have had long front limbs and a disproportionately large head while the adults, about five meters long would have tiny heads and long necks and were most likely bipedal, given that their forelimbs were much shorter than their hind limbs. This implies that as the dinosaur matured, their necks and hind limbs grew much faster than their forelimbs and head. Later dinosaurs in this group, the sauropods, had body proportions more similar to those of the *Massospondylus* embryos. Another feature, or lack of it, is that the embryos did not have teeth, and this aspect combined with the awkward body proportions, suggests that the hatchlings may have required parental care.

Ed Yong, an award-winning British science writer, posted the following blog about polar bear evolution (http://blogs.discovermagazine.com/notrocketscience/2010/11/08/for-polar-bears-the-price-of-rapid-evolution-is-a-weaker-skull/) on November 8, 2010: "For polar bears, the price of rapid evolution is a weaker skull." Polar bears split off from their closest relatives as recently as 150,000 years ago, an example of an evolutionary success story. It is believed that it took 20,000 years to evolve the many adaptations that allowed them to survive the arctic environment. For one, polar bears are the only bears that eat only meat, adapted to live off the flesh of seals. Like animals that swim, its eyes are positioned high on their skulls. As for thrusting into dens and breathing holes of seals, its body is flatter and more slender than those of other bears. "A polar bear's teeth are also unusual, and again their diet is to blame. Their menu consists almost entirely of blubbery flesh, which doesn't need much done to it before it is swallowed. Other bears with more varied diets have to chew through tough plant matter; polar bears don't, so their molars are smaller. Other carnivores need to shear flesh from bone, so they have specialized blade-like teeth for the job; polar bears don't, so they lack these well-developed secateurs." Much of the above discussion was derived from a paper published in PLoS ONE, November, 2010, volume 5, issue 11 by Graham J. Slater et al., "Biomechanical Consequences of Rapid Evolution in the Polar Bear Lineage" (http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0013870). Slater writes that "Our results suggest that continuation of current climate trends could affect polar bears by not only eliminating their primary food source but also through competition with northward advancing, generalized brown populations for resources that they are ill-equipped to utilize." Projected climate trends in coming decades will have profound effects on polar bear populations by decreasing the availability of suitable denning sites as well as eliminating much of the polar sea ice over which this specialized ursid forages for its seal prey. Furthermore, climate-driven northward expansion of temperate ecosystems and their associated faunas has already begun to facilitate the movement of brown bears into polar bear territory. The continued survival of the polar bear in the face of global climate change will ultimately depend on a range of factors, including behavioral and physiological flexibility. The transition to an arctic environment and hypercarnivorous diet resulted in extremely rapid morphological evolution in the polar bear lineage. "Our results indicate that the rate of cranial shape evolution in the polar bear lineage was at least twice as fast as in other branches of ursid phylogeny. Our estimate is probably conservative; while the phylogeny that we used for rate estimates dates the polar bear/brown bear split at approximately 700 thousand years ago, recent analysis of subfossil polar bear remains suggests that polar bears diverged from brown bears as recently as 150 thousand years ago, and that the modern polar bear morphology was present by 130 thousand years ago. The paper presents an analysis of the cranial shape of polar bears and brown bears that includes a chart showing a time-calibrated ursid phylogeny for assessing rates of cranial evolution.

A press release on November 15, 2010 from the University of Portsmouth provides us with information about a new study related to the flying ability of giant pterosaurs by Dr. John Whitton, University of Portsmouth, United Kingdom, and Dr. Michael Habib of Chatham University in Pittsburgh (http://www.port.ac.uk/aboutus/newsandevents/frontpagenews/title,120057,en.html). They say that the controversial claims that enormous prehistoric winged beasts could not fly have been refuted by their most comprehensive study to date, which asserts that not only were giant pterosaurs skilled in flight but their study shows how they took to the air. They state that the giant reptiles took off by using all four of their limbs and effectively "pole-vaulting" over their wings using their leg muscles and pushing from the ground using their powerful arm muscles. Once airborne, they

could fly huge distances and even cross continents. Their research is published in the international Public Library of Science journal, PLoS ONE (http://www.plosone.org/article/info:doi/10.1371/journal.pone.0013982), "On the Size and Flight Diversity of Giant Pterosaurs, the Use of Birds as Pterosaur Analogues and Comments on Pterosaur Flightlessness." They discuss the debate about whether extinct giant pterosaurs, the largest of which were the height of giraffes, could fly—a question that has divided paleontologists in recent years. Previous suggestions that pterosaurs were flightless were based on assumptions that they were too heavy or because they would have taken off like birds, by running or leaping into their air using just their hind limbs. Dr. Witton said: "Most birds take off either by running to pick up speed and jumping into the air before flapping wildly, or if they're small enough, they may simply launch themselves into the air from a standstill. Previous theories suggested that giant pterosaurs were too big and heavy to perform either of these maneuvers and therefore they would have remained on the ground. But when examining pterosaurs, the bird analogy can be stretched too far. These creatures were not birds; they were flying reptiles with a distinctly different skeletal structure, wing proportions and muscle mass. They would have achieved flight in a completely different way to birds and would have had a lower angle of take off and initial flight trajectory. The anatomy of these creatures is unique." Drs. Witton and Habib suggest that, with up to 50 kgs of forelimb muscle, the creatures could easily have launched themselves into the air despite their massive size and weight. Dr. Witton, said: "The size of the flight muscles in a giant pterosaur would be incredible: they alone would be up to 50 kgs and account for 20 percent of the animal's total mass providing tremendous power and lift." Dr. Habib added, "Scientists have struggled for decades to figure out how giant pterosaurs could become airborne, and some recent proposals have simply assumed it must have been impossible. But they may have approached the problem from the wrong end: instead of taking off with their legs alone, like birds, pterosaurs probably took off using all four of their limbs. By using their arms as the main engines for launching instead of their legs, they use the flight muscles—the strongest in their bodies—to take off, and that gives them potential to launch much greater weight into the air. This may explain how pterosaurs became so much larger than any other flying animals known." Some scientists have argued that these animals were too heavy to achieve flight, but the new study asserts that the animals were slightly smaller and lighter than previous theories have assumed, which changes the entire premise. Previous theories have asserted that giant pterosaurs could have been six meters tall with a wingspan of up to 12 meters but Dr. Witton and Dr. Habib argue that five meters high with a 10-meter wingspan would have been more realistic. "Weight estimates based on a 12 meter wingspan will be almost twice that based on 10 meters so an accurate assessment is vital," Dr. Witton said. The researchers examined every possible anatomical aspect of the prehistoric flying reptiles, which died out 65 million years ago along with the dinosaurs. Using fossilized remains, they estimated size and weight and calculated bone strength and mechanics and potential "flap gliding" performance. It's unlikely that they would need to flap continuously to remain aloft but would flap powerfully in short bursts, with their large size allowing them to achieve rapid cruising speeds. Dr. Witton said, "Pterosaurs had incredibly strong skeletons: for their weight, they're probably amongst the strongest ever evolved. And unlike birds, where the wings become relatively weak as they grow in size, those of pterosaurs do the opposite: they become stronger. As pterosaurs became larger, they reinforced their wings and expanded their flight muscles to ensure they could keep flying…One of the reasons why pterosaur research is so tricky is that there is very little in the way of fossilized remains. We're working with extremely small numbers of fossil specimens. You could take all the giant pterosaur fossils in the world and fit them on to a coffee table," Dr. Witton said. Dr. Witton also said: "All the direct data we have on pterosaurs, even the largest, suggests they were capable of flying. And after almost a century in the doldrums, we're starting to see far more progressive research on pterosaurs. It's not quite a revolution but we're certainly going through something of a renaissance." The press release also provides a video demonstrating the theory of pterosaur takeoff as understood by the authors. Another summary of the work can be viewed on Examiner.com by Paul Hamaker for November 17, 2010 (http://www.examiner.com/paelenotology-science-news-in-national/new-evidence-giant-pterosaurs-were-great-fliers), "New Evidence: Giant Pterosaurs Were Great Fliers," which contains some additional illustrations.

"For millions of years, insects and plants coevolved—leaf eaters adapting to the modifications of their hosts and plants changing to protect themselves from herbivory. The abundance and diversity of both insects and plants have varied depending on changes in climate." This statement introduces an article provided by the Ecological Society of America on Physorg.com, "Ancient insects preferred warmer climates," on November 23, 2010 (http://www.physorg.com/news/2010-11-ancient-insects-warmer-climates.html). The article says, based on a study by Ellen Currano et al., that abnormally high global temperatures have historically led to greater diversity and abundance of insects, separate from plant diversity and adaptations. Her team examined a total of 9,071 fossilized leaves belonging to 107 species and the presence or absence of 71 types of insect-feeding damage at nine sites in the Big Horn Basin in Wyoming that have the fossils dating back to 52.7–

59 million years. The importance of these locations is that the sediments formed during a period when global temperatures gradually warmed to the greatest sustained highs in the last 65 million years. The research paper was published in *Ecological Monographs*, volume 80, number 4, pages 547–567 as "Fossil insect folivory tracks paleotemperatures for six million years," the abstract of which states that "paleoecological studies enhance our understanding of biotic response to climate change because they consider timescales not accessible through laboratory or ecological studies…Superimposed on gradual warming is a transient spike of high temperature and pCO_2 (partial pressure of carbon dioxide in the atmosphere and the Paleocene-Eocene thermal maximum 55.8 Ma) and a subsequent cooling event (~54 MA)." Because the stratigraphy is well documented and the fossils are readily abundant, the Big Horn Basin is uniquely suited to examine the long-term effects of temperature change on the two dominant groups of terrestrial ecosystems, plants and insect herbivores. The authors conclude that there was a strong positive correlation between changes in damage richness and changes in estimated temperature, a weak positive relationship for damage frequency and temperature, and no significant correlation for floral diversity. Thus, the insect herbivore damage during the warm intervals suggests the northward migration of highly diverse and specialized insect populations from lower latitudes. Based on their conclusions, today's warming can alter insect herbivore populations and distribution and "cause a cumulative increase in herbivore damage at middle latitudes."