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OTHER MEDIA REVIEW

Paleontology and Evolution in the News

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

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Dinosaur Extinction Began Earlier

"Some dinosaurs may have been on the way to extinction millions of years before an asteroid hit the Earth 65 million years ago…" is a description of an article "New Theory on Dinosaur Extinction Offered" posted in UPI.Com (http://www.upi.com/Science_News/2012/05/01/New-theory-on-dinosaur-extinction-offered/UPI-24151335909841/?spt=hts&or=7). The report is accompanied by a rather colorful illustration of *Tyrannosaurus rex*, a member of the carnivorous groups of animals that the research suggests maintained a stable level of biodiversity leading up to the mass extinction at the end of the Cretaceous. The new study's lead author is Stephen L. Brusatte (Columbia University and American Museum of Natural History). He and his colleagues say that their findings show that the large plant-eating dinosaurs had been declining for 12 million years before the asteroid hit 65 million years ago at the end of the Cretaceous. Dr. Brusatte said that "Few issues in the history of paleontology have fueled as much research and popular fascination as the extinction of non-avian dinosaurs." Basically, the researchers looked at dinosaur extinction based on "morphological disparity," the variability of body structure. They say that "dinosaur groups that showed an increase in variability might have been evolving into more species, giving them an ecological edge, while decreasing variability might be a sign of extinction in the long term." The article is based on a press release from the American Museum of Natural History "New Research: Some Dinosaur Groups Diminishing Before Mass Extinction" (http://www.amnh.org/news/2012/05/new-research-some-dinosaur-groups-diminishing-before-mass-extinction/). Accompanying the press release is a 2-minute and 43-second web chat with museum paleontologists. The discussion details the question: were dinosaurs already undergoing a long-term decline before an asteroid hit at the end of the Cretaceous about 65.5 million years ago? The new study led by the researchers gives a multifaceted answer. Steve Brusatte asks "Did sudden volcanic eruptions or an asteroid impact strike down dinosaurs during their prime? We found that it was probably much more complex than that, and maybe not the sudden catastrophe that is often portrayed." The scientists looked at the change in variability within a given dinosaur group over time, then created a rough snapshot of the animals' overall well-being. The researchers calculated morphological disparity for seven major dinosaur groups using wide-ranging characteristics of the intricate skeletal structure of nearly 150 different species. They found that hadrosaurs and ceratopsids, two groups of large-bodied, bulk-feeding herbivores—animals that did not feed selectively—may have experienced a decline in biodiversity in the 12 million years before the

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dinosaurs ultimately went extinct. In contrast, small herbivores (ankylosaurs and pachycephalosaurs), carnivorous dinosaurs (tyrannosaurs and coelurosaurs), and enormous herbivores without advanced chewing abilities (sauropods) remained relatively stable or even slightly increased in biodiversity. The findings were published in the journal *Nature Communications*, "Dinosaur Morphology diversity and the end-Cretaceous extinction" (http://www.nature.com/ncomms/journal/v3/n5/abs/ncomms1815.html). Here we mention that while the paper discusses the decline taking place before end-Cretaceous "volcanism and bolide impact," the newspaper article cited above and some others preferred to leave out the volcanic cause of the extinction.

Dinosaur Gaseous Emissions Could Have Warmed the Earth

While Google (www.google.com) listed 21 news article related to the preceding paper after 6 days, the following report listed 145 news stories after five hours and over 500 after a week. Perhaps catchy titles help to get noticed. However, notice the difference between the URL and the headline (http://www.foxnews.com/scitech/2012/05/07/dinosaurs-farted-their-way-to-extinction-british-scientists-say/). The news story says "Dinosaurs may have farted themselves to extinction, according to a new study from British scientists." The story line continues: The researchers calculated that the prehistoric beasts pumped out more than 520 million tons of methane a year—enough to warm the planet and hasten their own eventual demise. They also say that until now, an asteroid strike and volcanic activity around 65 million years ago seemed the most likely cause of their extinction. The authors David M. Wilkinson, John Moores University; Euan G. Nisbet, University of London; and Graeme D. Ruxton, University of Glasgow say in their study that the giant plant-eating sauropods were the key culprits (*Current Biology*, volume 22, number 9, pages R292–R293). Some of the news items followed this line but most did not. What did the researchers say? The press release that was issued through EurekaALert (http://www.eurekalert.org/pub_releases/2012-05/cp-gef050112.php) says that the researchers worked out just how much of the greenhouse gas the large herbivore dinosaurs would have generated during the Mesozoic era, starting 250 million years ago. "A simple mathematical model suggests that the microbes living in sauropod dinosaurs may have produced enough methane to have an important effect on the Mesozoic climate," Wilkinson said. "In fact, our calculations suggest these dinosaurs may have produced more methane than all the modern sources, natural and human, put together." The dinosaur output of 520 million tons is comparable to current natural and man-made emissions of greenhouse gases, which scientists say is around 21 times more powerful than CO_2 at trapping heat on Earth and causing climate change. Cows and other farm animals globally contribute up to 100 million tons a year of methane. In it they say that unlike most modern browsers which are restricted to low growing vegetation, sauropods could access high tree foliage. The ability to access high as well as low browse because of their large body mass may partly explain why we infer sauropod methane emissions to have been much greater than those of modern-day ruminants. In their article, they conclude that the Mesozoic trend to sauropod gigantism led to the evolution of immense microbial vats unequaled in modern land animals. Methane was probably important in Mesozoic greenhouse warming. Taken together, "our calculations suggest that sauropod dinosaurs could potentially have played a significant role in influencing climate through their methane emissions." In addition, "although dinosaurs are unique in the large body sizes they achieved, there may have been other occasions in the past where animal-produced methane contributed substantially to global environmental gas composition: for example it has been speculated that the extinction of megafauna coincident with human colonization of the Americas may be related to a reduction of atmospheric methane levels." The study's conclusions not only show "just how strange and wonderful the workings of the planet are" but also serve as a useful reminder for the importance of microbes and methane for global climate, the researchers say.

Jurassic Insects Plagued Dinosaurs

Christopher Joyce writes in NPR (http://www.npr.org/2012/05/06/152019967/the-dinosaurs-nemeses-giant-jurassic-fleas) on May 6, 2012, in "The Dinosaurs' Nemeses: Giant, Jurassic Fleas," that fossil-hunting scientists are coming to grips with a new discovery that could change forever how we think of dinosaurs. What they've found is that dinosaurs may well have been tortured by large, flea-like (pseudofleas) bloodsucking insects. So it looks like the dinosaurs suffered just as we mammals did—and still do from these nasty critters. "Fleas were thought to have evolved along with mammals—they like our soft skins and a diet of warm blood." But now scientists in China have discovered *Pseudopulex jurassicus* and its equally tyrannical cousin, *Pseudopulex magnus*—magnus as in "great." Zoologist George Poinar, Jr., a professor emeritus from Oregon State University who studies life trapped and preserved in amber, says they were big, at least several times as big as current fleas and had the equipment to feed. He says "They have this large beak. Oh, it looks horrible. It looks like a syringe when you go to the doctor to get a shot or something." He also said that the fleas had long legs, not built for jumping, but perhaps for grabbing onto the scales on a dinosaur. The article is partly based on the press release from Oregon State

University (http://oregonstate.edu/ua/ncs/archives/2012/may/jurassic-pain-giant-%E2%80%9Cflea-like%E2%80%9D-insects-plagued-dinosaurs), "Jurassic Pain: Giant Flea-like Insects Plagued Dinosaurs." In the press release, Poinar says "These are really well-preserved fossils that give us another glimpse of life into the really distant past, the Cretaceous and Jurassic." All true fleas are adapted to feeding on warm-blooded vertebrates, Poinar said, and today 94 percent of the 2,300 known species attack mammals, while the remainder feed on birds. But the unusual characteristics and abilities of the flea-like animals found in these fossils lead scientists to believe their prey were some of the biggest kids on the block—dinosaurs—where they could have fed on the softer skin between scales. Poinar was referring to the paper published in *Current Biology*, volume 22, pages 732–738, by Tai-Ping Gao, Capital Normal University, Beijing and others, "Mid-Mesozoic Flea-like Ectoparasites of Feathered or Haired Vertebrates." The paper formally describes the insects, including an extensive discussion of their characteristics and a number of photographs of the taxa found in Inner Mongolia, China. They say that it has been widely accepted that mammals were the primary hosts of primitive fleas and only later did these fleas move from mammals to birds. They propose that the ectoparasitic lifestyle might have originally arisen to victimize feathered dinosaur or pterosaurs and then transitioned to mammals and birds, diversifying alongside the latter by reducing size, shortening stylet mouthparts, and minimizing serrated structure. Poinar, in the same issue of *Current Biology*, pages R278–R280, "Palaeontology: The 165-Million-Year Itch," writes that the above new flea-like fossils from China provide a rare, tantalizing glimpse of bizarre insects in the Cretaceous and Jurassic. He continues that although at this time it is difficult to determine if these pseudofleas are the direct ancestors of our modern fleas or represent a completely separate lineage that disappeared before the Tertiary. Poinar also points to an unexpected coincidence (and a rare event in paleontology), the publication of a paper describing the same Mesozoic fossils by a different group of authors. However, they describe the fossils insects as definitive fleas—which Poinar says, given the morphological differences, "are definitely not true fleas." Recognizable true fleas of the Order Siphonaptera have been around for at least 40–50 million years and occur in both Baltic and Dominican amber. However, no fleas with modern features have been found in Mesozoic deposits. See, D. Huang and others (2012), "Diverse transitional giant fleas from the Mesozoic era of China," *Nature*, volume 483, 201–204.

Supernovae Helped Life Thrive

Supernova explosions when stars "die" are among the most destructive events in the universe—but a new study suggests that the "blast wave" from supernovae might have energized life on our planet. Rob Waugh writes about this conclusion in Mail On Line, April 25, 2012, (http://www.dailymail.co.uk/sciencetech/article-2134841/Rays-life-New-study-shows-life-Earth-blossomed-nearby-supernovas-bathed-planet-cosmic-radiation.html?ito=feeds-newsxml) "Rays of Life? Fossils show that life on Earth blossomed when nearby supernovas bathed our planet in cosmic radiation." When supernovae explode, life prospered. "The evolution of life mirrors the evolution of the Galaxy," says Prof. Henrik Svensmark of the Technical University of Denmark. He suggests that different star clusters have caused life to blossom—explosions in the Pleiades, for instance caused diversity in marine animals called ammonites about 135 million years ago. He writes that when a supernova is close enough to the solar system, galactic cosmic rays wash over the Earth. He has looked back through 500 million years of geological and astronomical data and considered the proximity of the Sun to supernovae as it moves around our galaxy, the Milky Way. Comparing the rate at which supernovae exploded near the solar system with the geological record, he found that the changing frequency of nearby supernovae seems to have strongly shaped the conditions for life on Earth. "Whenever the Sun and its planets have visited regions of enhanced star formation in the Milky Way Galaxy, where exploding stars are most common, life has prospered." He studied a number of groups of animals from the fossil record and says that they tended to be richest in their variety when continents were drifting apart and sea levels were high, and less varied when the land masses gathered 250 million years ago into the supercontinent called Pangaea when sea level was lower. But this geophysical effect was not the whole story. What needs to be added is the rate of nearby stellar explosions, with the variety of life being greatest when supernovae are plentiful. A likely reason, according to Prof. Svensmark, is that the cold climate associated with high supernova rates brings a greater variety of habitats between polar and equatorial regions. "Life's prosperity, or global bioproductivity, can be tracked by the amount of carbon dioxide in the air at various times in the past as set out in the geological record. When supernova was high, carbon dioxide was scarce, suggesting that flourishing microbial and plant life in the oceans consumed it greedily to grow." He also says that most geological periods seem to begin and end with either an upturn or a downturn in the supernova rate. The article contains images of supernovae explosions as well as a graph that shows "the rate of supernova explosions correlates strongly to evolution—as judged by changes in fossils found under the ocean." The report is based on a press release from the Royal Astronomical Society "Did exploding stars help life on Earth to thrive?" (http://www.ras.org.uk/news-and-press/219-news-2012/2117-did-exploding-stars-help-life-on-earth-to-thrive). Henrik Svensmark's research was published online in the Monthly Notices of the Royal Astronomical Society, April 24, 2012. "Evidence of nearby supernovae affecting life on

Earth (doi:10.1111/j.1365-2966.2012.20953.x) The paper contains a statement of caveats: "The present results are no better than the data on which they are built, and the uncertainty of the data gets larger as one reaches further into the past. Estimated variations in SN [supernova] rates are better determined for 250–0 million years ago than for 500–250 million years ago, because there are fewer clusters of old ages and phase mixing tends to erase part of the memory of the birthplaces of the open clusters. On the other hand, consistencies in the comparisons with geological data lend support to the estimated supernova rates, even in the earlier period. Without direct terrestrial records of the galactic cosmic ray variation on long time scales, the highly fluctuating flux due to nearby supernovae remains a matter of numerical modeling, but again the geological record of sudden drops in sea level appears to support the analysis. It remains to be seen whether future improvements in astrophysical and geological data will show them continuing to mesh in the ways suggested here.

Largest Crocodile

What's the largest known living crocodile? It's the Nile crocodile attaining lengths almost to 21 feet. But the longest crocodile probably grew to 27 feet in East Africa some four to two million years ago. To see a comparative image, download the story in the *New York Daily News* by Erik Ortiz, May 9, 2012, "Ancient crocodile was history's largest, could gulp down grown man in a single bite" (http://www.nydailynews.com/news/world/ancient-crocodile-history-largest-gulp-grown-man-a-single-bite-article-1.1074883). The article also contains an image of a modern crocodile. Christopher Brochu, University of Iowa, said that the largest fossil specimen recovered belonged to massive crocodiles some 25 feet in length but probably grew to 27 feet. The specimen was originally excavated from the Turkana Basin, an area surrounding Lake Turkana in northern Kenya, a region famous for human fossil discoveries. Brochu said it's possible that the crocodiles fed on the ancestors of humans living there. It is also possible that the crocodiles swallowed them whole. To make the point, the accompanying illustration of a modern and this fossil crocodile contains a human and human ancestor figures for comparison. The justification for swallowing human ancestors whole can be seen in the illustration showing them to be much smaller in stature than the present time. This article and several others are based on the press release from the University of Iowa (http://now.uiowa.edu/2012/04/ui-professor-identifies-largest-known-crocodile) by Garry Galluzzo, May 5, 2012. Brochu also says that although the fossils contain no evidence of human/reptile encounters, crocodiles generally eat whatever they can swallow, and humans of that time period would have stood no more than four feet tall. Brochu did not find the fossil in the field but in the collection of the National Museum of Kenya in Nairobi where he was examining fossils in their collection. This is not the first time that undescribed fossils stored in a collection, often for dozens of years, had lain waiting for a sharp-eyed researcher to discover their distinctive features. Other experts who had seen the fossil did not recognize it as a new species. He said that it took four men to lift the skull of one of the specimens. He named the crocodile *Crocodylus thorbjarnarsoni* after John Thorbjarnarson, a famed crocodile expert and Brochu's colleague, who died of malaria while in the field several years ago. "He was a giant in the field, so it only made sense to name a giant after him." Brochu says that the new species is not directly related to the present-day Nile crocodile, which suggests that the Nile crocodile is a fairly young species. "We really don't know where the Nile crocodile came from but it only appears after some of these prehistoric giants died out." The result of Brochu's study is published in the *Journal of Vertebrate Paleontology*, volume 32, Issue 3, May 2012, pages 587–602, "A giant crocodile from the Plio-Pleistocene of Kenya, the phylogenetic relationships of Neogene African crocodylines, and the antiquity of *Crocodylus* in Africa," available online May 3, 2012 (doi:10.1080/02724634.2012.652324).

Ammonites Reproductive Strategy

Ammonites changed their reproductive strategy from initially few and large offspring to numerous and small hatchlings. Thanks to their many offspring, they survived three mass extinctions, a research team headed by paleontologists from the University of Zurich and elsewhere write in the news release on April 23, 2012, "First fertile, then futile: ammonites or the boon and bane of many offsprings" (http://www.mediadesk.uzh.ch/articles/2012/einst-fruchtbar-dann-fruchtlos-ammoniten-oder-fluch-und-segen-vieler-nachkommen_en.html). The research team was headed by Kenneth De Baets, University of Zurich. Before dying out at the end of the Cretaceous with the dinosaurs, they were successful for 300 million years, the "ultimate survivors." Ammonoids, also known as ammonites, were marine cephalopods believed to be related to today's squid and nautiloids. "At the beginning of their evolution, ammonoids had straighter shells, which, like other mollusks, began to coil during the Devonian Period." Why they did so is unknown; perhaps, coiling gave them better protection against their predators, but the shell change also affected the ammonoid embryos. "There were two more evolutionary trends that coincided with the increasingly more tightly coiled shells: The size of the embryonic shells shrank increasingly over time—the hatchlings became smaller and smaller. In parallel, the shell size of fully grown animals increased and, on the whole, the animals became increasingly bigger." The researchers found that the number of offspring increased substantially during the Devonian Period, confirmed

by discoveries of substantial clusters of fossilized embryonic shells at the end of the Devonian Period and more recent deposits. "The large number of offspring could have been the key to the rapid proliferation of the ammonoids in the aftermath of each mass extinction," De Baets suspects. Nevertheless, the once successful reproductive strategy of many offspring appears to have turned against them at the end of the Cretaceous Period—the ammonoids died out. Only nautiloids have survived until today, characterized by large young and a small number of offspring. Exactly how this circumstance had a positive impact upon the survival of the nautiloids is unknown. The research was published by Kenneth De Baets, Christian Klug, Dieter Korn, and Neil H. Landmann, "Early evolutionary trends in ammonoid embryonic development", in *Evolution, International Journal of Organic Evolution*, 14 February, 2012, doi:10.1111/j.1558-5646.2011.01567.x. Some of the authors' conclusions are: Loosely coiled embryonic shells with an umbilical window got lost during progressive coiling of the embryonic shell within lineages and preferential extinction of lineages with exclusively loosely coiled embryonic whorls… The preferential extinction during events related with important ecological changes suggests the possible importance of embryonic shell coiling, hatchling size, and/or reproductive strategies for survival during such events.

Permian Extinction

Paleontologists often write about the five major extinctions that have taken place in the history of life on planet Earth. One of them during the Permian Period was particularly devastating when perhaps as much as 95% of marine life forms on earth were killed off. What caused such an overwhelming loss of species has been the focus of many researchers since it was first recognized. Alan Mitchell (*New York Times*, "Science Times," Tuesday, May 1, 2012) writes about a modern attempt to discover the cause or causes. He writes that "among the hypotheses are a devastating asteroid strike, as in the Cretaceous extinction; a catastrophic volcanic eruption; and a welling-up of oxygen-depleted water from the depth of the ocean." The article is based on two of the following scientific papers by Jonathan L. Payne, Stanford University and Matthew E. Clapham, University of California, Santa Cruz: "Acidification, anoxia, and extinction: A multiple logistic regression analysis of extinction selectivity during the Middle and Late Permian," *Geology*, November 2011, v. 39, p. 1059–1062, first published on October 4, 2011, http://geology.gsapubs.org/content/39/11/1059.abstract and "End-Permian Mass Extinction in the Oceans: An Ancient Analog for the Twenty-First Century?" *Annual Review of Earth and Planetary Sciences*, volume 40, pages 89–111, http://www.annualreviews.org/doi/abs/10.1146/annurev-earth-042711-105329. In their annual reviews paper, they state that the greatest loss of biodiversity in the history of animal life occurred at the end of Permian about 252 million years ago. Basically, their study of fossil chemistry indicates that there was a disruption in the global carbon cycle. The only event that seems to support this hypothesis is the major volcanic eruption forming the Siberian Traps (lava flows) that released huge amounts of carbon dioxide into the atmosphere and through the hydrologic cycle into the ocean that led to long-term acidification and heating of oceanic water as well as reducing the oxygen content of the oceans. "The Siberian Traps (including extensive basalts in the subsurface of the West Siberia Basin) constitute one of the largest, if not the largest, continental flood basalt provinces that erupted during Phanerozoic time." Their conclusions of these past events lead to the comparison of today's situation where coral reefs in many parts of the world are suffering. They say that as human impacts push environmental conditions to extremes not experienced in the recent past, the geological record is increasingly essential as an archive of past experiments in global change.

Recovery After the Permian Extinction

It has been suggested that recovery after the Permian extinction event took five million years. A paper by Haijun Song, China University of Geosciences and others, shows that through their high-resolution sampling of more than 10,000 microfossils from seven Late Permian–Middle Triassic paleoequatorial sections in south China in level-bottom seafloor diversity, recovery began in the early Smithian, a little more than one million years after the mass extinction., while recovery of reef-building metazoans began four million years later (*Geology*, August 2011, volume 39, number 8, pages 739–742, "Recovery tempo and pattern of marine ecosystems after the end-Permian mass extinction.")

Thrips in the Cretaceous

"Researchers discover oldest pollinators entombed in amber" is the headline of the story written by Thomas H. Waugh II, May 15, 2012 in the *Los Angeles Times* (http://www.latimes.com/news/science/sciencenow/la-sci-sn-oldest-pollination-20120515,0,4109257.story?track=rss). He writes that studying amber from Cretaceous era deposits, an international team of paleontologists have discovered the oldest known insects engaged in pollination. The thrips (110 million to 105 million years old) were found coated in pollen grains that were presumably used to feed the insects' offspring. Thysanopterans, commonly called thrips, are tiny, slender insects with fringed wings—hence the name from the Greek *thysanos* (fringed) and *pteron* (wing). Although modern thrips may be pollinators, they are generally considered pests because they eat plant tissues in economically important plants. A team headed by paleontologist Enrique Peñalver of the Instituto Geologico y Minero de

Espana in Madrid found the specimens in amber in the Basque-Cantabrian Basin of northern Spain. They imaged the insects using the synchrotron at the European Synchrotron Radiation Facility (ESRF) in Grenoble, France. He also writes that the thrips had hundreds of pollen grains stuck to their bodies. The exterior of the insects had highly specialized hairs with a ringed structure to increase their ability to collect pollen grains, very similar to those of contemporary pollinators like bees. The small pollen grains are believed to come from a cycad or ginkgo tree. Ginkgos are either male or female, and males produce pollen that must be transported to the female tree by wind or insects. The researchers speculated that the thrips established colonies in the female trees and carried pollen from the male trees to feed their offspring. "Thrips might turn out to be one of the first pollinator groups in geological history" and at this time, the only one from the Age of Dinosaurs, said paleontologist Carmen Soriano of ESRF one of the researchers who led the investigation of the amber pieces with X-ray tomography. The article and others like it is based partly on a news report from ESRF on May 15, 2012 by Gary Admans (http://www.esrf.eu/news/general/ pollination/index_html/). Surprisingly, the headline is "Where bees are, there will be honey (even prehistoric)" even though the report has nothing to do with bees. He writes that "Today, more than 80% of plant species rely on insects to transport pollen from male to female flower parts. Pollination is best known in flowering plants but also exists in so-called gymnosperms, seed-producing plants like conifers. Although the most popular group of pollinator insects are bees and butterflies, a myriad of lesser known species of flies, beetles or thrips have co-evolved with plants, transporting pollen and in return for this effort being rewarded with food." He says that only amber can preserve behavioral features like pollination in such rich detail over millions of years. The news release is well illustrated with images of the pollen trapped within the amber, a reconstruction of a thrip with pollen attached to the body over an ovulate organ of a ginkgo, and several other tomographic images. Enrique Peñalver and his co-researchers published the paper the Proceedings of the National Academy of Science (www. pnas.org/cgi/doi/10.1073/pnas). In addition to the images mentioned above, the article contains a chart which portrays hypothetical thysanopteran–seed plant pollinator relationships, indicating the colonization of cycads, angiosperms, and probable ginkgoaleans. In part this is what the authors have to say in their abstract: "Within modern gymnosperms, conifers and Ginkgo are exclusively wind pollinated whereas many gnetaleans and cycads are insect pollinated. For cycads, thrips are specialized pollinators. We report such a specialized pollination mode from Early Cretaceous amber of Spain, wherein four female thrips representing a genus and two species in the family Melanthripidae were covered by abundant Cycadopites pollen grains."

Mystery of the Domestication of the Horse Solved

A new study of the history of the domestic horse was published in the *Bangor Daily News* by Sara C.P. Williams, *Science News*, May 9, 2012 (http://bangordailynews.com/2012/05/09/news/nation/genetic-study-traces-history-of-the-domestic-horse/?ref=latest). She describes how putting a place and date on the domestication of horses has been a challenge to archaeologists. But there is some evidence in the shards of pottery with traces of mare's milk, mass gravesites for horses and drawings of horses with plows and chariots—nevertheless, not enough. She describes how a team of geneticists studying modern breeds of the animal has assembled an evolutionary picture and has come to the conclusion that they were first domesticated 6,000 years ago in the western part of the Eurasian Steppes, modern-day Ukraine, and West Kazakhstan. Not only had these early domestic horse interbred with wild horses, but through time, they were traded with populations of people and moved across continents making their genetic history hard to follow. She also tells how the wild ancestor of the horse, *Equus ferus*, is extinct, complicating researchers' efforts to compare the genetics of domestic animals with wild ones. Earlier genetic "studies relied mostly on mitochondrial DNA, which is only inherited from a mother, to try to understand horses evolutionary history." Quoting biologist Vera Warmuth, University of Cambridge, the lead author of the study, "The problem was that there was a lot of diversity in the mitochondrial DNA. Every horse breed has almost all the mitochondrial lineages represented. Warmuth instead studied sequences of horse DNA inherited from both parents and known to be diverse between horse populations. She and her colleagues collected genetic samples from more than 300 horses at 12 different sites across the steppe. Data were collected for only working animals bred within a local area, not those bred for show or appearance, to minimize any human-guided selection that would make some genes more common." The results of their computer simulation showed that the wild ancestor of domestic horses originated in the Eurasian Steppes 160,000 years ago and was domesticated in the western part of Eurasian Steppe about 6,000 years ago. Williams in her article indicates that not all researchers are convinced, however. University of Cambridge archaeologist Marsha Levine said she thinks using modern genetic samples to retrace horses' evolution is a dead end. "There's been mixing of cultures and mixing of horses in this region for many thousands of years," she says. "And so when you're looking at any modern horse, you just don't know where it's from." Bringing together many kinds of evidence is what will ultimately answer the whens and wheres of horse domestication, Levine says. "What we need to be doing is using material from excavations, sequencing ancient genes, and combining that with what we know from archaeological evidence about how animals were used in the past." The newspaper article was partly based on a press release from

Cambridge University (http://www.cam.ac.uk/research/news/mystery-of-the-domestication-of-the-horse-solved/). In order to solve the perplexing history of the domestic horse, scientists from the University of Cambridge used a genetic database of more than 300 horses sampled from across the Eurasian Steppe to run a number of different modeling scenarios. Dr. Vera Warmuth, from the University of Cambridge's Department of Zoology, said "Our research clearly shows that the original founder population of domestic horses was established in the western Eurasian Steppe, an area where the earliest archaeological evidence for domesticated horses has been found. The spread of horse domestication differed from that of many other domestic animal species, in that spreading herds were augmented with local wild horses on an unprecedented scale. If these restocking events involved mainly wild mares, we can explain the large number of female lineages in the domestic horse gene pool without having to invoke multiple domestication origins." The results of the researchers work was published as follows: Vera Warmuth, Anders Eriksson, Mim Ann Bower, Graeme Barker, Elizabeth Barrett, Bryan Kent Hanks, Shuicheng Li, David Lomitashvili, Maria Ochir-Goryaeva, Grigory V. Sizonov, Vasiliy Soyonov, and Andrea Manica, "Reconstructing the origin and spread of horse domestication in the Eurasian steppe," *Proceedings of the National Academy of Sciences*, 2012 doi:10.1073/pnas.1111122109. The authors say that despite decades of research across multiple disciplines, the early history of horse domestication remains poorly understood. On the basis of current evidence from archeology, mitochondrial DNA, and Y-chromosomal sequencing, a number of different domestication scenarios have been proposed, ranging from the spread of domestic horses out of a restricted primary area of domestication to the domestication of numerous distinct wild horse populations. "In this paper, we reconstruct both the population genetic structure of the extinct wild progenitor of domestic horses."

Genes Shed Light on Spread of Agriculture in Stone Age

A press release (http://www.uu.se/en/news/news-document/?id=1808&area=2,10,16&typ=artikel&na=&lang=en) from the University of Uppsala on April 26, 2012 describes a study shedding light on the spread of agriculture in the Stone Age as follows. "One of the most debated developments in human history is the transition from hunter-gatherer to agricultural societies. This week's edition of *Science* presents the genetic findings of a Swedish-Danish research team, which show that agriculture spread to Northern Europe via migration from Southern Europe. We have been able to show that the genetic variation of today's Europeans was strongly affected by immigrant Stone Age farmers, though a number of hunter-gatherer genes remain," says Assistant Professor Anders Götherström of the Evolutionary Biology Centre, who, along with Assistant Professor Mattias Jakobsson, co-led the study, a collaboration with Stockholm University and the University of Copenhagen. "What is interesting and surprising is that Stone Age farmers and hunter-gatherers from the same time had entirely different genetic backgrounds and lived side by side for more than a thousand years, to finally interbreed," Mattias Jakobsson says. Agriculture developed in the Middle East about 11,000 years ago and by about 5,000 years ago had reached most of Continental Europe. How the spread of agriculture progressed and how it affected the people living in Europe have been debated for almost 100 years. Earlier studies were largely based on small amounts of genetic data and were therefore unable to provide univocal answers. Was agriculture an idea that spread across Europe or a technique that a group of migrants took with them to different regions of the continent? "Many attempts, including using genetics, have been made to come to terms with the problem since the significance of the spread of agriculture was established almost 100 years ago," Anders Götherström says. "Our success in carrying out this study depended on access to good material, modern laboratory methods and a high level of analytical expertise." The study in question entailed the research team using advanced DNA techniques to characterize almost 250 million base pairs from four skeletons of humans who lived during the Stone Age 5,000 years ago. Just ensuring that the DNA obtained from archaeological material is truly old and uncontaminated by modern DNA requires the use of advanced molecular and statistical methods. The study involved thousands of genetic markers from the four Stone Age individuals, of which three were hunter-gatherers and one was from an agricultural culture. All of the archaeological data show that the Stone Age farmer was representative of his time and group and was born and raised near the place of his burial. The researchers compared their findings with a large amount of genetic data from living individuals. "The Stone Age farmer's genetic profile matched that of people currently living in the vicinity of the Mediterranean, on Cyprus, for example," says Pontus Skoglund, a doctoral student who developed new analytical methods used in the study. "The three hunter-gatherers from the same time most resembled Northern Europeans, without exactly matching any particular group." Accordingly, the study strongly supports the thesis that the agricultural revolution was driven by people who migrated from Southern Europe. That they lived side by side with the hunter-gatherers for many generations, to eventually interbreed, explains the patterns of genetic variation that characterize present-day Europeans. "The process appears in the end to have had the result that nobody today has the same genetic profile as the original hunter-gatherers, although they continue to be represented in the genetic heritage of today's Europeans," Pontus Skoglund says. Jan Storå, researcher at Stockholm University, says the results are extremely exciting for archeology in general and research into the Stone Age in particular. "Archaeology has become a stimulating interdisciplinary field. We have obtained new, concrete biological data

about Stone Age people that provides scope for discussions about origins, mobility, and social networks pertaining to a period that has lately been the focus of lively debate. Scientific DNA studies have broadened the basis for engaging discussions within archaeology in recent years," Jan Storå says. An 8.5-minute interview with Mattias Jakobsson, Department of Ecology and Genetics, Evolutionary Biology is provided via YouTube (http://www.youtube.com/watch?v=G8MlPZB-8H8&feature=youtu.be). The research was published in *Science*: P. Skoglund, H. Malmstrom, M. Raghavan, J. Stora, P. Hall, E. Willerslev, M. T. P. Gilbert, A. Gotherstrom, M. Jakobsson, "Origins and Genetic Legacy of Neolithic Farmers and Hunter-Gatherers in Europe," *Science*, 2012; 336 (6080): 466 doi:10.1126/science.1216304. A supplemental audio *Science* podcast is included with the paper. In the same issue of *Science*, pages 400–401, News&Analyses section Michael Balter comments on the paper in "Ancient Migrants Brought Farming Way of Life to Europe." The article summarizes the work of the researchers and interviews several scientists for comments about the results. The upshot is that the findings support the hypothesis that "farming originated in southern Europe and spread throughout Europe into Scandinavia." Nevertheless, much research remains to be done before all pieces of the puzzle of European origins and the spread of farming can be filled in.