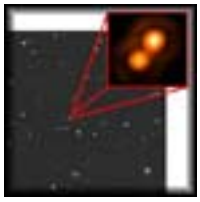
Smithsonian

Spotlight on Science at the Smithsonian

Bi-Weekly Newsletter | Vol. 4, No. 1 | 03 January 2006

- Introduction from Dr. David Evans, Smithsonian Under Secretary for Science

- Botany's Type Collection



- Hydrogen Cyanide Discovered in the Early Universe

- DNA Profiling Solves Another Cold Case

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Spotlight on Science at the Smithsonian is a bi-weekly electronic newsletter about Science at the Smithsonian. It is produced for the Smithsonian community by the Office of the Under Secretary for Science. To subscribe to the newsletter or Podcast, visit science.si.edu.

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Introduction from the Under Secretary for Science

This issue of Spotlight on Science is all about origins: botanical, stellar and cultural.

First we hear about National Museum of Natural History scientists who have developed a completely digital, high resolution collection of tens of thousands of images of plant specimens in the National Herbarium. This tremendous collection of data is available instantaneously to scientists around the world as they classify and study relationships between species of plants.

Next, using techniques of gravitational-lens imaging we first explored in our last issue, Smithsonian Astrophysical Observatory researchers have observed a super bright and massively distant quasar as it appeared 1.6 billion years after the Big Bang, about 14 billion years ago. This window on the early universe is revealed in unusual detail by the light-bending effects of an intervening galaxy. This gravitational lensing magnifies the quasar by a factor of 10 to 20 times, revealing what may be a hot bed of stellar birth.

And finally, we learn about new DNA evidence in a story 10,000 years in the making. Archeologists and geneticists at the National Museum of Natural History study DNA samples that suggest that bottle gourds and dogs accompanied paleo-Indian groups as they migrated to the Americas from Asia. Since the migration occurred before the domestication of food crops or livestock, the evidence suggests that domestication as a hallmark of human development was spurred not by a desire to produce reliable sources of food, but rather to provide the utility of a trusty companion in the case of dogs, and as indispensable container in the case of bottle gourds.

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Type specimen of *Licania kanukuensis*, collected by former NMNH Director A.C. Smith in British Guiana (Guyana) in 1938.

Botany's Type Collection

Web Links

Department of Botany web site:
http://www.nmnh.si.edu/botany

Verified type images:
http://ravenel.si.edu/botany/types

In the world of plant taxonomy, type specimens are fundamental to understanding the link between a plant species and its published name. They allow us to revisit the work of earlier scientists as new information or technologies become available. The Department of Botany in the National Museum of Natural History (NMNH) has assembled one of the finest collections of type specimens in the world and it has been the subject of many innovative developments over the years.

In 1966, under the stewardship of Mason Hale and Stanwyn Shetler, a groundbreaking effort was begun to digitally collect all the taxon and collection information from the type specimens. This included an effort to confirm the type status of each specimen by checking the published original description of each species name. The result was a fully verified, collection of 82,500 type specimens that became a standard for systematics collections around the world. Each year between 500 and 1000 new type specimens are added.

A couple of years later, Botany's Collections Manager, Rusty Russell, initiated the first use of bar codes in any systematics collection. Tracking, reconciliation and accountability was improved as a result and, again, NMNH was leading the way among biology collections.

In 2000, Russell outfitted a digital imaging studio and began to create high resolution images of each type specimen. The goal, since realized, was to make these images available on the Internet so that scientists, researchers and students around the globe would have immediate access to these critical resources. Through the support of a National Science Foundation grant, the task was completed in the spring of 2005. More than 90,000 scaled-down type images are now available on the Department of Botany web site. Additions occur every week as new type specimens are included and older types are returned from loan. One unexpected outcome of this project is that the lending of type specimens has been reduced by about 80% as more scientists find answers online. With reduced handling, NMNH is better able to preserve each specimen while continuing to provide a high level of access. NMNH can also fulfill requests for full size digital images. These image files become even more critical in the event of any unfortunate specimen loss or damage.

As soon as the imaging project was complete, NMNH began to assemble country subsets of the high resolution images so that they could be sent directly to the countries in which they were collected. The first sets of type images are being sent to Mexico, Colombia and the Philippines and NMNH will soon distribute entire image sets to many of

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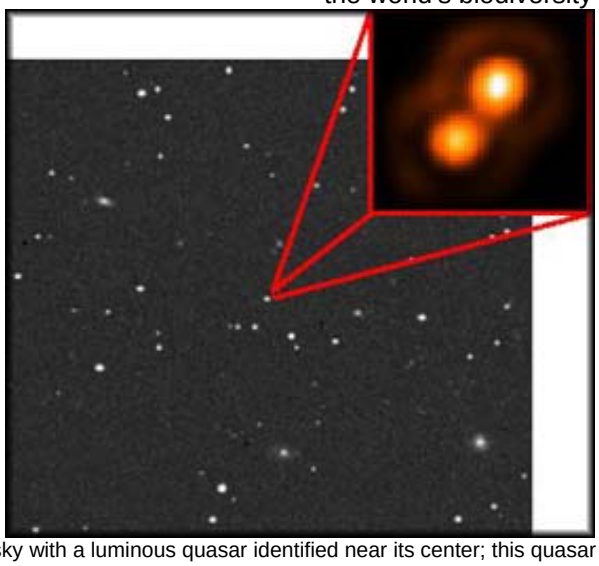
the world's biodiversity centers.



An optical view of the sky with a luminous quasar identified near its center; this quasar is so far away from Earth that its light was emitted when the universe was only about 1.6 billion years old. The inset, a magnified optical image of the quasar taken by the Hubble Space Telescope, shows that distorted, 'gravitational lensing' by a foreground object has produced a double image of this same quasar. SAO astronomers have discovered hydrogen cyanide (HCN) in this remote object, the first discovery of this molecule in anything that existed when the universe was so young.

Hydrogen Cyanide Discovered in the Early Universe

Quasars are luminous galaxies powered, astronomers think, by super massive black holes at their centers. Quasars are so bright that they can be seen even though they are very far away. The combination of being both highly energetic and located great distances from the Earth, makes quasars interesting to astronomers who are trying to better understand both the nature of black holes and the conditions in the early universe that prompted these monsters to form.

Occasionally a quasar is found with even more unusual properties, and such is the case of the quasar called APM 082279+5255. This quasar is so far away from Earth that its light was emitted when the universe was only about 1.6 billion years old. It is one of the most luminous known objects in the universe, shining with the energy of about a thousand trillion Suns. It happens that the light from this quasar passes near another, closer galaxy on its way to Earth, and the closer galaxy acts as a gravitational lens to enhance the quasar's light, by about a factor of 10 to 20.

Smithsonian Astrophysical Observatory (SAO) astronomer David Wilner and a graduate student working with him, Jeff Wagg, together with three of their colleagues, report in a recent issue of *Astrophysical Journal Letters* that they have now discovered HCN (hydrogen cyanide) for the first time in such a remote object, thanks in part to the enhancement produced by the gravitational lens. The HCN emission is brighter than expected. The team speculates that it may be exceptionally bright because increased ionization near the black hole has enhanced the molecule's abundance; the emission corresponds to there being about three hundred billion solar masses of dense gas, mostly in molecular hydrogen, in the quasar. There is another perhaps even more interesting consequence. The team also notes that in galaxies in our neighborhood bright HCN emission signals the presence of ongoing bursts of new star formation. They suggest therefore that APM 082279+5255 may also be undergoing this kind of activity. The results shed light not only on black holes, but also on what is happening in some of the first galaxies in the universe.

Reference

J. Wagg et al., "HCN J-5-4 Emission in APM 08279+5255 at z=3.91", *Astrophysical Journal Letters*, 2005, 634, L13.

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Photo of a bottle gourd seed.

DNA Profiling Solves Another Cold Case

Reference
David L. Erickson, Bruce D. Smith, Andrew C. Clarke, Daniel H. Sandweiss, and Noreen Tuross, "An Asian origin for a 10,000-year-old domesticated plant in the Americas", *Proceedings of the National Academy of Sciences*, 2005, 102: 18315-18320

In a paper published recently in the *Proceedings of the National Academy of Sciences* ("An Asian origin for a 10,000-year-old domesticated plant in the Americas"), National Museum of Natural History (NMNH) archaeologists and geneticists, analyzing the DNA signature of bottle gourd fragments recovered from ancient settlements in North and South America, reported evidence that this Old World "container crop" was already domesticated when it reached the Americas more than 10,000 years ago. Even more surprisingly, the crop was introduced from Asia rather than Africa, as previously thought. This remarkable discovery strongly supports the "Utility Theory of Domestication," a theory that holds that people first domesticated both the dog and the bottle gourd (known as the "two camp-followers") in Asia to help in critical everyday tasks rather than domesticating them first as food. Furthermore, the theory hypothesizes that this domestication took place several thousand years before any food crop or livestock species was domesticated anywhere in the world. Since both the dog and the bottle gourd were already domesticated, both would have accompanied Paleo-Indian groups as they traveled into the New World. First author for this path breaking paper is postdoctoral fellow David Erickson, who did the genetics lab work at the NMNH Laboratories of Analytical Biology (LAB) facility. Former LAB member and NMNH Research Associate, Noreen Tuross, now with Harvard University, is another author on the paper.

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