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Spotlight on Science at the Smithsonian

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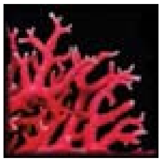

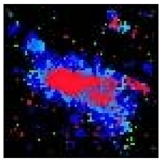

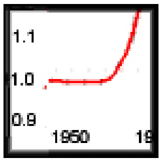

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- Theresa Mellendick, Editor, mellendickt@si.edu

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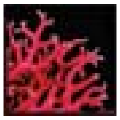
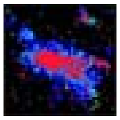

Stresses abound for Coral Ecosystems


Urban Dwellers, not Nomads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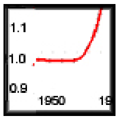

Radiocarbon Dating of Human Remains

Introduction from the Under Secretary for Science

In this installment of the Spotlight on Science, we travel to Panama to learn how a researcher at the Smithsonian Tropical Research Institute has discovered the surprising impact of sugar compounds on coral reef ecology. From there we are off to the lonely plains of Mongolia where National Museum of Natural History anthropologists have unearthed evidence that complex urban centers were integral to the power of the mogul empire. Back at the Smithsonian Astrophysical Observatory in Cambridge, Mass., we'll take a peek at dim, dwarf galaxies, and hear how astronomers are peering into the undernourished stellar dust in the hopes of discovering the keys to the formation of our own complex and resource abundant galaxy. And our last foray takes us to the forefront of forensic medicine, where Smithsonian anthropologists are focusing on the more recently deceased. Natural History researchers are showing how the radioactive remnants of mid-twentieth century nuclear bomb testing inadvertently provides a radioactive clock that starts ticking in our bones as soon as death occurs.

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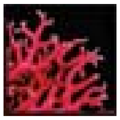

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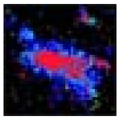

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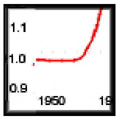

Radiocarbon Dating of Human Remains

New research suggests sugars may overfeed bacteria on corals.

Stresses abound for Coral Ecosystems

Complex coral reef ecosystems around the globe are under such severe attack that scientists have a hard time simply figuring out which of the many threats is most fearsome. Reefs are extremely diverse ecosystems, and symbiotic relationships abound, confounding cause and effect relationships. While scientists have long suspected that phosphates, nitrates and ammonia, found in the agricultural runoff and sewage associated with coastal development, contribute to reef loss, Smithsonian Tropical Research Institute marine biologist David Kline has uncovered a new menace; sugars.

Kline, a researcher, at the Bocas del Toro Research Station in Panama, conducted a large-scale ecotoxicology study in Caribbean coral reefs, using a custom designed and built dosing system that allowed him to test the effects of 40 different chemicals on 400 replicate corals in each experiment. When he exposed the corals to nitrates and phosphates he found 7% mortality rate among the corals. However, when he presented carbon compounds in the form of simple sugar molecules to the corals, nearly 35% of them died. Kline has found that, unlike the other chemicals, sugar leads to an explosive growth of normally symbiotic bacteria, disrupting the balance between the healthy coral and its associated bacterial community, leading to disease and death in the coral. The question now is whether these lab findings are applicable to real-life situations. According to Kline, corals are already under stress from warming waters and the loss of fish and urchins that eat the algae that competes with corals for space. With weakened defenses, simply boosting the growth rate of the symbiotic bacteria with the influx of sugar may be enough to push corals over the edge. If the findings hold, it will show that monitoring carbon levels in reef areas may be critical to slowing the loss of these invaluable ecosystems.

Reference

Meeting Briefs from AAAS Annual meeting, *Science*, 2006, Vol. 311, 1094.

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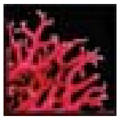

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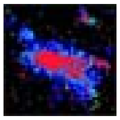

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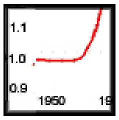

Radiocarbon Dating of Human Remains

Dan Rogers at Khar Balgas, summer 2002

Urban Dwellers, not Nomads

The Mongol empire founded by Chinggis Khan was the largest contiguous empire in human history. Scholars have regarded Mongol empires as being nomadic, highly mobile political confederations. However recent research suggests otherwise. In the December 2005 article, "Urban centres and the emergence of empires in eastern Inner Asia", published in *Antiquity*, Smithsonian Museum of Natural History Department of Anthropology Chair Daniel Rogers and colleagues Erdenebat Ulambayar and Mathew Gallon report on their discoveries regarding the inner mechanics of Mongol empires.

Contrary to earlier interpretations, Roger's American-Mongolian team found that the large political confederations which characterized the great Mongol empires of the first and second millennia AD actually had urban centers that provided central points of trade, administration, agriculture, craftsmanship and military operations. These centers made use of highly sophisticated urban places that featured advanced planning and design, and impressive monuments that served a variety of functions. The center included open spaces within the walls reserved for tent neighborhoods and the development of extensive irrigation systems beyond the city walls. Rogers' study demonstrates that past interpretations of the Mongol empires have overemphasized the nomadic aspects of the economy.

Reference

Dan Rogers, E. Ulambayar and M. Gallon, "Urban centres and the emergence of empires in eastern Inner Asia", *Antiquity*, Vol. 79, No. 306: 801–818

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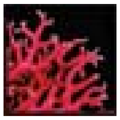

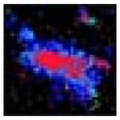

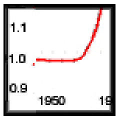

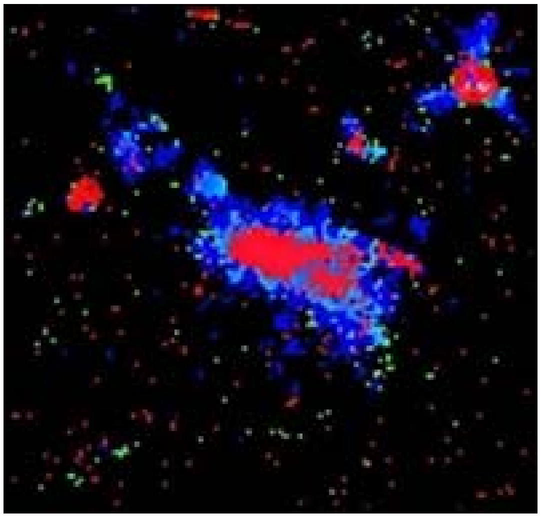

A dwarf galaxy as seen by the Infrared Array Camera. SAO astronomers have discovered that dwarf galaxies come in a surprisingly wide diversity of types. The central object and those to the upper left are all parts of this galaxy, which has a very "irregular" shape. (The objects in the upper right are unassociated, foreground stars). The blue color traces the stellar component of the galaxy while the red color traces the hot dust.

Dwarf Galaxies

Our own Milky Way is a normal galaxy with roughly one hundred billion stars. By comparison, a dwarf galaxy is quite small and may have as few as only a hundred thousand stars. This small number of stars makes dwarf galaxies very much dimmer than normal ones, and much harder to study. Dwarf galaxies are also peculiar in that they seem to have a drastically smaller amount of elements heavier than hydrogen and helium, such as carbon, oxygen, or nitrogen. A few extreme dwarfs, for example, have relative abundances of elements (compared to hydrogen) that are only about 5% of the values found in our solar system. The reasons for this are not understood, but then neither is the reason for the very existence of dwarf galaxies. Nevertheless, dwarf galaxies are thought to be important for two principle reasons. The first is that normal galaxies, including our Milky Way, may have evolved from the gradual merging of many dwarf galaxies. Thus dwarf galaxies may hold a clue to the early life of the Milky Way. The second is that the heavier elements are essential to life, and scientists trying to understand better how the congenial environment of Earth developed want to understand why some places are rich in such heavy elements, while others are not.

Smithsonian Astrophysical Observatory astronomers Jessica Rosenberg, Matt Ashby, and Jia-Sheng Huang, together with a colleague, have studied a set of nineteen dwarf galaxies that are known to be producing at least some new stars. The team used the Spitzer Space Telescope and its Infrared Array Camera to study the properties of the warm dust in these galaxies. This dust is heated by young stars and is bright at infrared wavelengths. In a recent article in the *Astrophysical Journal*, the astronomers report that these dwarf galaxies are striking in their diversity of appearance in the infrared. Some seem to be deficient in dust and lacking in star formation activity, even when taking into account a possible deficiency of heavy elements. Others, although they are dwarfs in size, are as active in producing stars and heating up dust as much bigger, normal systems. Now that astronomers realize that there is a wide diversity of types, and have begun to characterize the nature of those differences, they plan to try to study more closely the key parameters in order to understand the origins of the diversity and any implications they may have for the Milky Way and its stars.

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J. Rosenberg, M. Ashby, J. Salzer, and J-S. Huang, "The Diverse Infrared Properties of a Complete Sample of Star-forming Dwarf Galaxies," *The Astrophysical Journal*, 2006, 636, 742.

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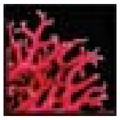

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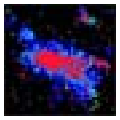

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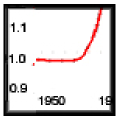

Radiocarbon Dating of
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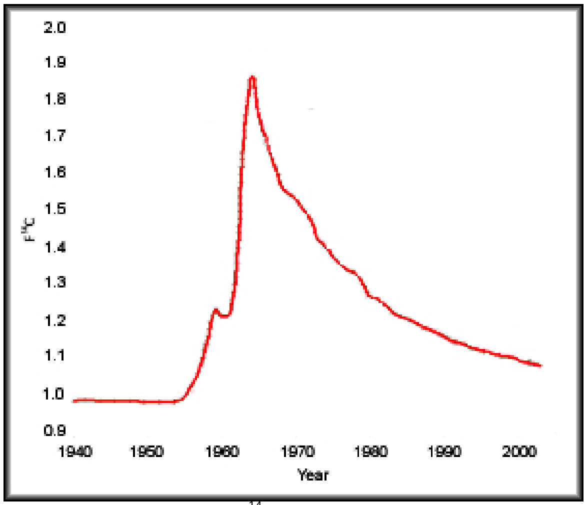

Average annual atmospheric $^{14}CO_2$ record for the Northern Hemisphere. Annual averaging smoothes the curve and reduces the 1963 peak.

Radiocarbon Dating of Human Remains

Forensic anthropologists study skeletal remains to identify individuals and examine evidence used to determine the cause of death. It is sometimes difficult to determine how long an individual has been deceased from skeletal remains. Because radiocarbon (^{14}C) is incorporated into all living things, including human bones, radiation from a bomb pulse can serve as an "isotopic chronometer" (instrument to measure time) for the past half-century.

Testing of nuclear weapons during the 1950s and early 1960s doubled the level of radiocarbon in the atmosphere ($^{14}CO_2$). Bomb-curve radiocarbon dating has given rise to a method of analyses forensic anthropologists can use to determine the time of death for skeletal remains. From its peak in 1963, the level of atmospheric $^{14}CO_2$ has decreased exponentially, with a mean life of about 16 years, not because of radioactive decay, but because of mixing with large marine and terrestrial carbon reservoirs. The absence of bomb radiocarbon in skeletonized human remains generally indicates a date of death before 1950. Comparison of the radiocarbon values with the post-1950 bomb curve may also help clarify when in the post-1950 era the individual was still alive. Artificially high values clearly indicate the individual was alive in the post-1950 era.

A recent article by National Museum of Natural History Anthropologist Douglas Ubelaker and a colleague, B.A. Buchholz, analyzes the complexities in the use of bomb-curve radiocarbon to determine time since death of human skeletal remains. Interpretations of these data must consider possible significant differences between the time of bone formation and levels of atmospheric radiocarbon at the time of death, estimated ages or dates of individual tissues may lag actual age at death. This relationship appears to be influenced by diet, medical treatment, growth and remodeling patterns, age at death of the individual, types of tissue sampled, regional variation of ^{14}C concentrations, and other factors.

Reference

Complexities in the Use of Bomb-Curve Radiocarbon to Determine Time Since Death of Human Skeletal Remains. *Forensic Science Communications,* 2006, Vol. 8 No. 1.

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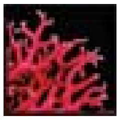

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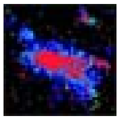

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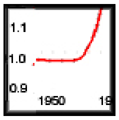

Radiocarbon Dating of Human Remains

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