Smithsonian Institution

Spotlight on Science at the Smithsonian

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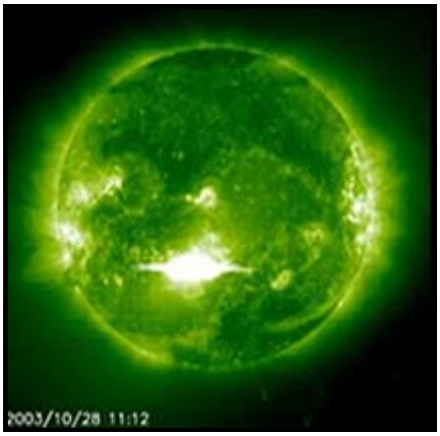
Calyptraeids attached to a variety of hard substrates, hermit crab shells, rocks and even the glass of aquaria.

Sedentary Snails Are Dynamic Globe Trotters

An article by Smithsonian Tropical Research Institute marine biologist Rachel Collin was featured on the cover of the October issue of *Systematic Biology*. Collin used DNA sequences to examine the relationships among 94 species of limpets in the Calyptraeid gastropod family.

The shells are commonly found on beaches, however the sedentary snails live in shallow marine environments in all the oceans, except the Arctic and Antarctic. Collin's family tree shows that these animals have actually moved around the globe and have crossed oceanic barriers numerous times. Although close relatives usually occur along the same coastline, Collin's results show that species of calyptraeids have moved between the Atlantic and Pacific oceans at least 12 times and between the northern and southern hemispheres at least 15 times.

These results indicate (1) that species ranges of many marine invertebrates may be more dynamic over evolutionary time than previously assumed, and (2) that close relatives do not always live in geographically proximate regions, but many do occur in the same areas. In calyptraeids the most closely related species often co-occur in the same habitats, suggesting that new species in this group formed without geographic barriers physically separating different populations. This geographic pattern is very different from the pattern that has been demonstrated far more often—a pattern that requires geographic separation.



An ultraviolet image (rendered in green) of the Sun taken during the extreme solar activity on October 30, 2003. The dramatic, erupting region is clearly seen in the lower center of the Sun's disk.

Diagnosing the Sun's Active Corona

The solar corona is the very hot (over a million degrees Celsius), extended, gaseous, outer atmosphere of the Sun. The corona can have active regions (spots with intense magnetic fields) that erupt, hurling energetic, charged particles towards the Earth as a part of a solar wind. These particles can damage satellites by building up charge in their electronic components and computer memory, thereby disrupting communications. Scientists do not understand exactly what causes these eruptions, but they do know being able to predict this kind of solar storm is very important - the eruption last week made headlines around the world, and prompted the New York

Times (October 29) to comment that the eruption could "even hamper fire fighting efforts in California [by interrupting communications]."

The Smithsonian Institution has been a pioneer in the study of the Sun since the time of Samuel Pierpont Langley, the third Secretary of the Institution, a solar astronomer himself, and the founder of the Smithsonian Astrophysical Observatory. SAO astronomers today watch the Sun closely using the Solar and Heliospheric Observatory (SOHO) satellite and their onboard instrument, the Ultraviolet Coronagraph Spectrometer (UVCS). SAO's UVCS is the only instrument able to measure the speeds and temperatures of electrically charged particles from certain portions of the extended solar corona. Scientists think that an understanding of the physical processes of the solar wind is essential to the development of a long-range space weather prediction capability.

Writing in the journal Astronomy and Astrophysics, SAO astronomers John Raymond, John Kohl, Yuan-Kuen Ko, Michael Uzzo, and Chi-Rai Wu, along with a colleague, report a major improvement with respect to previous studies in understanding the conditions of the very hot coronal gas located between about one and one-half to two solar radii from the Sun. They combined results from the UVCS instrument with radio wavelength observations to analyze the gas from thirty-seven solar bursts. Previous attempts to analyze this hot material assumed a generic, average density for the gas, but the SAO team used UVCS to obtain precise density information for each region immediately prior to its eruption. The astronomers found that the assumption of a single density was completely erroneous: there could be as much as a factor of ten variation in the coronal gas density across a single outburst region, and between different outbursts. Their results in turn enabled them to set limits to the shocked gas velocities in those regions, providing data to help astronomers prepare more accurate models for solar flares.

One of over 100 black-footed ferret kits produced by artificial insemination at the National Zoo's Conservation and Research Front Royal, VA. When more mature, most of these ferrets are reintroduced to the wild as part of the U.S. Fish and Wildlife Service's Black-Footed Recovery Program.

Black-Footed Ferrets—Once Lost, Now Found

North America's only native ferret once inhabited the Great Plains from Canada into northern Mexico, preying almost exclusively on prairie dogs. When prairie dogs were declared a pest species because they competed with livestock for forage, an effective extermination campaign decimated them and their principal predator—the black-footed ferret.

During the 1980s, the Wyoming Fish and Game Department (WFGD) sent some newly discovered black-footed ferrets to selected breeding facilities, including the National Zoo's Conservation and Research Center (CRC), whose staff had developed and mastered artificial insemination techniques that could increase ferret populations and maintain vital genetic diversity. Their breeding successes led to the release of 49 ferrets into Wyoming's Shirley Basin in October 1991, that were believed to have been wiped out by sylvatic plague three years later. Despite this setback, over the next twelve years, more than 1,600 black-footed ferrets were released onto seven sites in the Great Plains, with 90 of the animals released provided by CRC.

In August 2003, a WFGD biologist found a surviving group of about 40 ferrets some distance from the original 1991 release site. DNA analysis found that the population was inbred, confirming assumptions that the original population in Wyoming was drasti-

cally reduced by plague and remained at low numbers for many generations. CRC scientists were extremely gratified that not only has their hard work paid off with the success of more recent reintroductions, but that all along, the initial release in 1991 had actually been a twelve-year success. This discovery bodes well for the future of the tough little black-footed ferret on the Great Plains.

New sea cucumber feeding at a depth of 1,200 feet, Grand Cayman. Photo: Gary Montemayor.

Procrastination Has Its Virtues

In 1989, National Museum of Natural History scientist Dave Pawson and colleagues were diving in a research submersible near Barbados, reaching depths of about half of a mile. Most of the animals being studied were large enough to be seen with the naked eye, and could be photographed and videotaped live on the seafloor. Sometimes the scientists used a suction device to slurp up some mud or sand in hopes of finding small species or young stages of the larger animals.

In one of these slurped samples from a depth of about 1,400 feet was a small transparent sea cucumber less than two inches long. Its bizarre shape and other characteristics led Pawson to conclude that it represented a new family, genus, and species. For the past 14 years, Pawson delayed publishing a scientific description of this very rare specimen, in the hope that he might return to the area, find more specimens, and make a more comprehensive study.

Recently, Chris Pomory, a colleague in Florida, sent Pawson a photograph taken at a depth of around 1,200 feet on the "wall" at Grand Cayman by submersible operator Gary Montemayor. The photo shows a beautiful, almost-transparent sea cucumber, with a cylindrical body and tubular feeding tentacles embedded in the muddy bottom—without a doubt, the same new species that was captured near Barbados. The small whitish spots on its body are hundreds of microscopic bones in the form of perfect little wheels. Unfortunately, the submersible was not equipped to collect the animal.

So, now that the scientists have a specimen from Barbados and a stunning photo of the species from Grand Cayman, they can proceed with the scientific description. This development led Pawson to suggest a new aphorism: "What's worth doing is sometimes better done after a little procrastination".

African Elephant.

Understanding Is Key to Elephants' Survival

The Endocrine Research Laboratory (ERL) at the National Zoo's Conservation and Research Center (CRC) is the only laboratory dedicated to evaluating hormone activity in elephants. Because the ERL works with more than four dozen zoos and routinely evaluates many elephants, it has been able to identify several reproductive problems that most would likely have gone unnoticed.

One of these problems is that the captive African elephant population in North America is not self-sustaining. Based on a hormone evaluation, the ERL recently found that nearly 25 percent of captive African female elephants are not exhibiting normal reproductive cycles and, thus, cannot be bred. ERL researchers suspect this problem is the result of how these elephants have learned to adapt to the artificial social and environmental aspects of captivity.

African elephants in the wild live in complex hierarchical groups of related females. Their social structure differs from that of captive elephants in three ways: (1) captive groups are biased toward females—few facilities maintain bulls; (2) captive "herds" are not multigenerational, and calves are rare; and (3) the groups are small, with 75 percent of facilities maintaining three or fewer elephants. While captive groups differ from wild herds, dominance status may still be important for maintaining social harmony, even if there is no true matriarch.

Thus, understanding how behavioral and environmental factors influence reproductive fitness in various elephant populations, including those in captivity, is important. ERL researchers will examine whether these factors influence the reproductive hormone activity of captive elephants by comparing the environmental and social composition of each captive herd and studying how the temperaments of cycling and noncycling elephants differ.

Recent Publications

Bernardi, G.; Bucciarelli, G.; Costagliola, D.; Robertson, D.; Ross, D. Heiser, J.B. 2003. "Evolution of coral reef fish *Thalassoma* spp. (Labridae).1. Molecular phylogeny and biogeography," *Marine Biology* Online.

Collin, R. 2003. "Phylogenetic relationships among calyptraeid gastropods and their implications for the biogeography of marine speciation," *Systematic Biology*, 52: 613-640.

Mancuso, S.; Raymond, J.; Kohl, J.; Ko, Y.; Uzzo, M.; Wu, R.; 2003. "Plasma properties above coronal active regions inferred from SOHO/UVCS and radio spectrograph observations," *Astronomy and Astrophysics,* 400:347.

Penfold, L.M.; Jost, L.; Evenson, D.P.; Wildt, D.E.; 2003. "Normospermic versus teratospermic domestic cat sperm integrity evaluated by flow cytometry and intracytoplasmic sperm injection," *Biology of Reproduction*, 69:1730-1735.

Spotlight on Science at the Smithsonian

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