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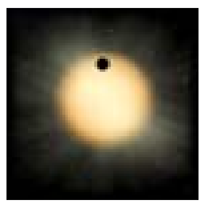
Spotlight on Science at the Smithsonian

Bi-Weekly Newsletter | Vol. 5, No. 2 | 26 January 2007

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



- Starlight Carries Clues About Orbiting Planets

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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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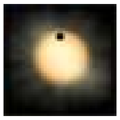

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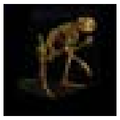

When Giant 'Roos Ruled

Biodiversity Quickly Withers in Forest Fragments

Introduction from the Under Secretary for Science

In this installment of Spotlight on Science we begin with one of the most exciting areas in astronomy today, the study of newly-discovered planets beyond our solar system. By analyzing the light from the stars these planets circle, Smithsonian astronomers can deduce the properties of the planets' orbits. Next we look into Australia's past with a mammalogist from the Museum of Natural History. During the Ice Age Australia was home to not just one, but several species of giant kangaroos. And finally, we turn to the current biodiversity crisis. A long-running experiment in the Amazonian rainforest is revealing that fragmented forests deteriorate even faster than had been previously thought, and that these changes may impact global climate.

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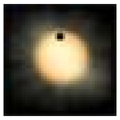

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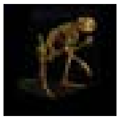

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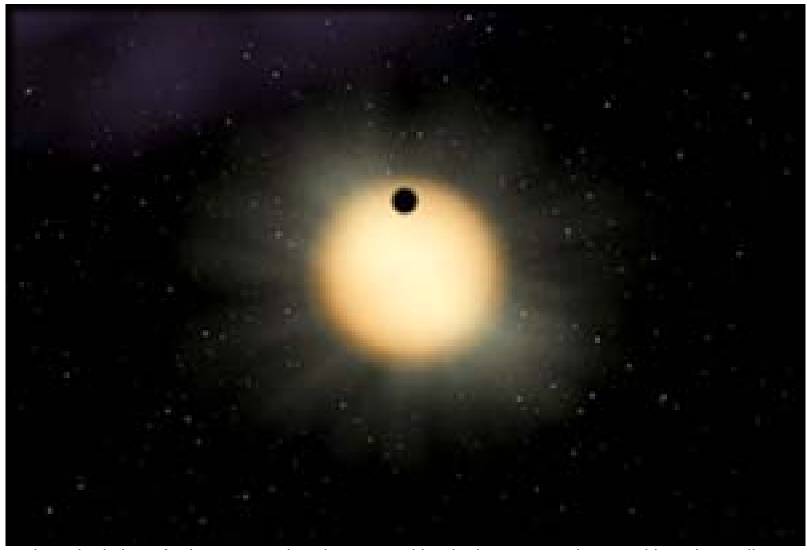

Artist's depiction of a large exosolar planet transiting its host star. The transiting planet distorts the star's spectrum, revealing details of its orbit.

Starlight Carries Clues About Orbiting Planets

The search for planets orbiting distant stars is not only interesting in its own right, but it also helps us understand the quirks of our own solar system. The orbits of Earth and the other planets circling our sun all lie nearly in the same plane, which is also in line with the plane of the sun's equator. This spin-orbit alignment, as it is called, presumably dates from the formation of the sun and planets from a single spinning disk of matter some five billion years ago.

Is this neat alignment inevitable? Or do the forces that congeal planetary systems sometimes lead to less orderly results? Smithsonian Astrophysical Observatory astronomer Matt Holman is a member of a team of twelve astronomers that has measured the orbital alignment of the stellar system HD 189733. This system lies about 63 light years away from Earth in the constellation Vulpecula. In 2005 a planet slightly larger than Jupiter was discovered in the system, orbiting its star every two days.

When a planet orbiting a far-way star passes in front of the star, it not only slightly dims the star's light as seen from earth, but it also distorts the color spectrum of the light. The distortion depends on the angle of the planet's orbit relative to the axis of the star's spin. By precisely measuring the star's spectrum, then, astronomers can calculate the relative orientation of the planet's orbit. Using observations from the Keck 10-meter telescope and a high-resolution spectrometer the researchers were able to measure the angle for HD 189733.

What they found was that the spin-orbit alignment matches within a couple of degrees. This makes HD 189733 the third known extra-solar planetary system with such a measured angle, and the third where the angle is small, as it is in our own solar system. Since otherwise all three solar systems are quite different from our own – the giant planet lies closer to its star than Mercury does to our sun, for example – the result implies that the spin-orbit alignment is not a peculiarity of our solar system or even our type of system. Whether it's a rule for all planetary systems is another question, one that only more observations will settle.

Reference

Joshua N. Winn, John Asher Johnson, Geoffrey W. Marcy, R. Paul Butler, Steven S. Vogt, Gregory W. Henry, Anna Roussanova, Matthew J. Holman, Keigo Enya, Norio Narita, Yasushi Suto, and Edwin L. Turner. 2006. Measurement of the Spin-Orbit Alignment in the Exoplanetary System HD 189733. *Astrophysical Journal*, 653: L69 - L72.

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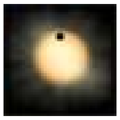

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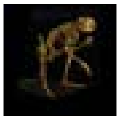

When Giant 'Roos Ruled

Biodiversity Quickly Withers in Forest Fragments

Skeleton of Simosthenurus occidentalis, one of several large kangaroos that became extinct near the end of the Pleistocene. Unlike today's kangaroos, which are mostly grazers, these extinct species were leaf-eaters.

When Giant 'Roos Ruled

Australia has always been famous for its kangaroos; the largest is the red kangaroo, which can weigh close to 200 pounds. Paleontologists have long known that in past ages Australia was home to even larger species of kangaroos, but they didn't how much larger. Now National Museum of Natural History scientist Kristofer Helgen and his Australian colleagues have used the limb bones of fossil kangaroos to estimate the weights of 11 extinct species. They found that the extinct kangaroos could weigh up to five hundred pounds. The biggest of the bunch, Procoptodon goliah, is the largest hopping mammal ever to exist.

In fact, until about 46,000 years ago large kangaroos would have been a common sight on the Australian landscape. Out of 11 species studied by Helgen's group, 10 had estimated weights larger than all living marsupial herbivores. Even still-living species were larger back then -- the eastern grey kangaroo which today averages about 90 pounds, achieved masses of up to 400 pounds. Then around 46,000 years ago many of the large species became extinct and surviving species began to shrink. The causes of this are obscure, but there are parallels on other continents, where many large-bodied mammals became extinct near the end of the Pleistocene epoch. Some researchers blame climate change for these events, others blame human hunters.

Whatever the reasons for the disappearance of the giant kangaroos, the Helgen et al research highlights other puzzles about these extinct animals. For example, biomechanical limits of the strengths of bone and tendon suggest that the optimum size of bipedal hoppers such as kangaroos is about 120 pounds. But the Pleistocene kangaroos exceeded this limit by a large margin. What kind of adaptations allowed them to do it? The more we learn about these vanished creatures the more they intrigue us.

Reference

Kristofer M. Helgen, Rod T. Wells, Benjamin P. Kear, Wayne R. Gerdtz and Timothy F. Flannery, 2006, Ecological and evolutionary significance of sizes of giant extinct kangaroos. *Australian Journal of Zoology*, 2006, 54, 293–303

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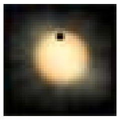

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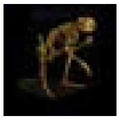

When Giant 'Roos Ruled

Biodiversity Quickly Withers in Forest Fragments

STRI biologist William Laurance and colleagues have found that tree communities in forest fragments change with remarkable speed. As old-growth trees die off, shade-tolerant understory species are replaced by fast-growing generalists.

Biodiversity Quickly Withers in Forest Fragments

Amazonian rainforests support a huge share of the world's biodiversity, most of it dependant on their diverse communities of tree species. Up to 300 species of trees can found in an area the size of two football fields. But the forests are rapidly being cleared for timber, cattle ranching and farming. Remaining forest is often reduced to small, irregularly-shaped "fragments," which may or may not be able to support healthy communities of rainforest-adapted plants and animals. In order to help preserve biodiversity in the Amazon and elsewhere, scientists need to understand the effects of fragmentation on biological communities.

Smithsonian Tropical Research Institute (STRI) ecologist William Laurance and colleagues have found that fragmentation of Amazonian rainforests by human encroachment leads to degradation of the remaining forest much more rapidly than previously thought. Even though the life cycles of many rainforest trees are measured in centuries or more, significant changes occur within just decades of fragmentation.

The Biological Dynamics of Forest Fragments Project, operated cooperatively by STRI and Brazil's National Institute for Amazonian Research, is the world's largest and longest running experimental study of habitat fragmentation. The study consists of a 1000-square kilometer experimental landscape in central Amazonia. In the early 1980s researchers created nine forest fragments ranging in size from 1 to 100 hectares (a hectare is 10,000 square meters, or about 2 ½ acres). The forest fragments were exhaustively inventoried for their plant and animal species before isolation, and re-sampled every 4-6 years afterwards in order to track changes in the biological communities. For this study, Laurance and his colleagues followed the fates of nearly 32,000 individual trees for approximately two decades.

They found that desiccation and wind damage can kill old-growth trees within 100 meters of forest edges, and these are replaced by fast-growing generalist species. Shade-tolerant understory species are particularly hard-hit, as are species dependant on rainforest animals for pollination and seed-dispersal. The resulting tree communities in fragments contain similar numbers of species as the original intact forest, but the species are different. And the communities are ecologically far less stable as species come and go at an accelerated rate.

The Biological Dynamics of Forest Fragments Project is an ongoing study. Researchers will continue to monitor the changes in the tree community and in the other plant and animal species that depend on the trees. One important implication of this study is that the fragmented forest is likely to store less carbon than equivalent areas of intact forest, both because many large, old-growth trees die in fragments and because the wood of the fast-growing trees invading the fragments is less dense than that of the old-growth trees they replace. Over the long-term, this could exacerbate the accumulation of greenhouse gases in the atmosphere.

Reference

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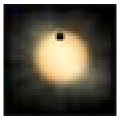

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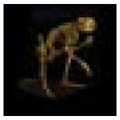

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