Smithsonian

Spotlight on Science at the Smithsonian

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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

In this installment of Spotlight on Science, we'll start by looking at research from the Smithsonian Astrophysical Laboratory. They are examining the movement of galaxies through the diffuse gas that permeates the space between galaxies. Next, We'll then look work being done at from the Smithsonian Tropical Research Institute (STRI) to examine migration of species across the Eastern Pacific Barrier (EPB). Charles Darwin described the EPB as an "impassable barrier", but STRI researchers have found that some species have been able to move in both directions across the barrier. Then, we'll look at the work of researchers at the National Zoological Park's Conservation and Research Center (CRC) who are examining cooperative meerkat societies. They have found that the dominant female, who holds a near monopoly on reproduction, holds this position in part by stressing-out other females, which causes them to be infertile. Finally, we'll look at another project from CRC—this one studying suburban biodiversity. Using cameras and global positioning system tracking devices, researchers examined the movement of deer, bears, and domestic cats. Results of this research will show how residential developments in forests are influencing biodiversity.

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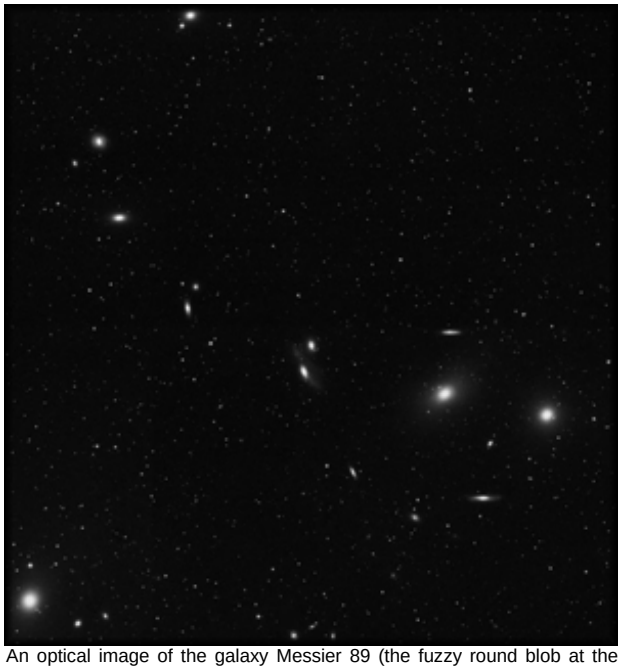

An optical image of the galaxy Messier 89 (the fuzzy round blob at the lower left) together with other associated galaxies in the Virgo cluster of galaxies. SAO astronomers have imaged and studied hot, X-ray emitting gas in M89 as it is stripped away as a result of the galaxy's supersonic motion through the intergalactic cluster gas.

A Supersonic Galaxy

Reference

M. Machacek, C. Jones, W. Forman, and P. Nulsen , "Chandra Observations of Gas Stripping in the Elliptical Galaxy NGC 4552 in the Virgo Cluster," *The Astrophysical Journal*, 644, 155, 2006.

In the cosmic scheme of things, galaxies frequently collide with one another. Astronomers see these stupendous collisions underway in optical images nearly everywhere they look in the sky. The Milky Way itself is thought to have suffered such collisions in its past, and even now is heading towards its nearest giant neighbor, the Andromeda Galaxy, at a rate that will bring the two together in another few billion years.

Astronomers believe that these powerful interactions help to produce massive stars that in turn enrich galaxies with chemical elements. Galaxies that are part of a larger group, even when they are not colliding with one another, are thought to move in a diffuse, intracluster medium made up of gas that permeates the space between the objects. Astronomers are not sure what happens to galaxies as they move through this bath, or how galaxy interactions might feed material back into that medium. The gas is extremely hard to detect in optical light, but it is hot and can be detected in X-rays. If the galaxy is moving fast enough through the surrounding medium, the pressure of the medium can shock, condense, and shape the gas, thereby giving it a characteristic signature.

Four Smithsonian Astrophysical Observatory astronomers working with the Chandra X-Ray Observatory, Marie Machacek, Christine Jones, Bill Forman, and Paul Nulsen, have measured hot gas being stripped away from a galaxy as it moves through its intracluster medium. The galaxy, Messier 89, is a member of the Virgo Cluster, a gravitationally interacting collection of about 1300 galaxies that are about 55 million light-years from Earth. The astronomers find three features characteristic of gas being stripped away from the host galaxy as it moves supersonically through a medium: a dense leading edge, double lobes of emitting gas extending out from that edge, and a cool and long trailing tail. The astronomers calculate that M89 is moving at about Mach 2.2 through the intracluster gas; that is, at a velocity of about 1700 kilometers per second, and at an angle of about 55 degrees to our line-of-sight. These results provide support for theories of how galaxies and their gas interact and evolve as they move in their rich cluster environment.

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Smithsonian researchers have found evidence of fish passing through an "impassable" barrier.

Fish Cross Impassable Barrier

The Eastern Pacific Barrier (EPB) is 5000 km of deep ocean separating the eastern and central Pacific. Charles Darwin termed the EPB an "impassable barrier." Reef fish generally live in shallow coastal waters. In order to understand whether reef fish can share genetic connections across the EPB, Smithsonian Tropical Research Institute (STRI) scientists, Harilaos Lessios and D. Ross Robertson have analyzed DNA samples from 20 species of reef fish on both sides of the divide. They found that most of these species maintain recent genetic connections.

It was previously thought that there was little larval migration from west-to-east, and no migration from east-to-west. There is no evidence that major changes in currents or sinking of an underwater platform would explain these results. If that were the case, several species would show the same time of separation. These new findings suggest that larvae indeed move in both directions.

Their findings, reported recently in the *Proceedings of the Royal Society B*, confirm close relationships between populations of the same species across the barrier. This indicates that genes move in both directions across the barrier. Although this research proves that the EPB is not truly an impassable barrier, it is still an effective barrier for most species, which are found only on one side of the barrier.

Reference

H.A. Lessios and D.R. Robertson, "Crossing the impassable: genetic connections in 20 reef fishes across the eastern Pacific barrier," *Proceedings of the Royal Society B*. 2006. 273, 2201-2208.

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Dominant female meerkats stress out subordinate females.

Dominant Meerkats Render Rivals Infertile

In a darker twist to our understanding of cooperative meerkat societies, new findings reveal that the dominant female, who largely monopolizes reproduction, achieves this in part by stressing-out her subordinates, causing them to become infertile. The findings are the result of a long-term collaboration between Steven Monfort at the National Zoological Park's Conservation and Research Center (CRC) and colleagues at the University of Cambridge, UK and the University of Pretoria, South Africa. These findings were recently published in the *Proceedings of the National Academy of the Sciences*.

Aggression is uncommon in meerkat societies, until the dominate female becomes pregnant. About a month before giving birth, she subjects the subordinate females to escalating attacks. These attacks end with the subordinates being temporarily driven from the group for the remainder of the dominant's pregnancy. While evicted, subordinate females suffer chronic stress, which interferes with their reproductive physiology, stopping them from conceiving and increasing their likelihood of aborting (had they already conceived). Seemingly, all is forgiven once the dominant gives birth. The subordinates return and help babysit and feed the young.

This study provides strong evidence that dominants in animal societies can use stress to suppress rivals' fertility. This is even more surprising in meerkat societies because the subordinates are typically the dominant's relatives and helpers. So, why does she do it? The simple answer, that it removes competition for the dominant meerkats's young, is certainly true. There is also a darker side to the story: when subordinate meerkats become pregnant, they will kill the young born to others, including those of the dominant. Thus by stopping subordinates from becoming pregnant, the dominant reduces the likelihood that her own offspring will be killed.

These findings contradict the consensus emerging from previous work on cooperative breeding species, that dominants do not use stress to suppress the fertility of their rivals. Further research is needed to determine whether meerkats are unusual in this regard or if stress related suppression is actually more widespread in animal societies than we now realize.

Reference

Andrew J. Young, Anne A. Carlson, Steven L. Monfort, Andrew F. Russell, Nigel C. Bennett, and Tim Clutton-Brock, "Stress and the suppression of subordinate reproduction in cooperatively breeding meerkats," *PNAS* 2006 103: 12005-12010.

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Camera-traps used by citizen scientists capture a wide range of wildlife, ranging from opossum and white-tailed deer to raccoon in residential neighborhoods of High Knob, Front Royal, VA.

Backyard Biologists Go High Tech

Have you ever wondered what animals walked through your backyard while you weren't looking? Worried about how far your cat strays from home? Researchers at the National Zoological Park's Conservation and Research Center (CRC) have partnered with High Knob area residents in Virginia to answer questions that will give them a picture of suburban biodiversity and the impacts of development on the natural environment. Community cooperation is key to the study and will hopefully shed light on reasons for increasing bear populations and higher-than-normal populations of deer. The project, led by Dr. Swen Renner, a postdoc at CRC's Conservation Geographic Information Systems (GIS) Laboratory, also seeks to educate residents about wildlife and how they can conserve and avoid conflicts with it.

To set up the project, eight residents received camera traps along with detailed instructions. They set up the camera and leave it in place for about two weeks. The camera is then moved to a new location. The film is changed and batteries checked. Then the film is delivered to CRC for analysis. As expected, many pictures of bears and white-tailed deer have been taken. In addition, residents are monitoring the movements of their domestic cats with Global Positioning System (GPS) tracking devices.

Back on CRC grounds, research is being conducted with another ten cameras combined with extensive field surveys to describe the songbird communities in residential areas and adjacent forests. Dr. Peter Leimgruber, the Director of CRC's Conservation GIS Laboratory, hopes that the project will become a multidisciplinary approach to citizen science, integrating diverse research and education programs at CRC. Already in the works are plans for expansion of the project to include aspects of migratory bird biology that make them vulnerable to residential developments. In addition, Dr. Leimgruber's team at the GIS lab will be modeling how future land use changes and residential development might affect Shenandoah wildlife communities.

Results from this effort will show whether and how residential areas in forests are influencing biodiversity in the area and what the conservation implications may be. It may provide new ideas for what local residents can do to protect their backyard biodiversity. Such strategies will be increasingly important as forest loss and residential development is rapidly increasing in Northern Virginia. Scientist and residents can work together to figure out how to save wildlife during such dramatic land use changes.

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