

# Spotlight on Science at the Smithsonian

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



- Australian Magpies: Flings on the Wing



- Scientists Shed Light on Mosquito  
Introductions Worldwide



- Ants are Their Own Best Medicine



- Most Stars are Single



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Australian Magpies:  
Flings on the Wing



Scientists Shed Light  
on Mosquito  
Introductions  
Worldwide



Ants are Their Own  
Best Medicine



Most Stars are Single

## Introduction from the Under Secretary for Science



In this installment of Spotlight on Science, we'll first examine the breeding habits of two populations of the Australian magpie. Researchers want to know if mates are selected for "good genes" or for diversification of the gene pool. Then we'll study the introduction of mosquitoes to the Hawaiian Islands. Studying this event can provide insight into the mechanisms for the spread of new and emerging diseases. Next, we'll look at a special adaptation of some ants. They harbor bacteria which produce antibiotics that allow them to live in what would otherwise be lethal environments. Finally, new findings suggest that most "middle-aged" stars are single, rather than part of binary pairs as was previously believed.



Australian Magpies:  
Flings on the Wing



Scientists Shed Light  
on Mosquito  
Introductions  
Worldwide



Ants are Their Own  
Best Medicine



Most Stars are Single



A male Australian magpie singing to defend his territory.

## Australian Magpies: Flings on the Wing

### Reference

Durrant, K.L. and Hughes, J.M. Differing rates of extra-group paternity between two populations of the Australian magpie (*Gymnorhina tibicen*). 2006. *Behavioural Ecology and Sociobiology* 57, 536-545.

Spring is here. All around us birds are singing and choosing their mates, making ready for another season's young. For many male birds, however, the hatchlings they help raise will not be their own. Genetic studies of a variety of bird species have revealed that on average 11 percent of a female's broods will have been sired by a male other than her mate. The current record holder for avian infidelity is the Australian magpie. For these social and highly territorial birds the figure can exceed 80 percent.

Kate Durrant at the National Zoo's Genetics Lab and her colleague Jane Hughes of Griffith University in Australia are using genetic paternity tests and field studies to understand the biological underpinnings of the magpies' racy sex life.

Why would female birds look beyond the nest for males to father their young? One popular explanation, the "good genes" hypothesis, is that the wayward females choose males that are genetically superior to their mates, resulting in higher quality offspring with better chances of survival. Another possibility, the genetic diversity hypothesis, is that females are simply hedging their bets, genetically speaking, by having their eggs fertilized by a number of different males. For the Australian magpies, which live and breed in tight social groups, dalliances with males outside the group could serve to replenish

the local gene pool, staving off the harmful effects of inbreeding.

Durrant and Hughes put these hypotheses to the test by comparing rates of extra-pair paternity in two subspecies of magpies: the western and the white-backed. These two magpies are similar in most aspects of their biology, but differ in one important aspect of their social behavior – whether offspring born into a social group stay with the group or disperse to join other groups. Juvenile western magpies rarely if ever leave their group, while more than half of the white-backed juveniles disperse after their first year.

If infidelity was simply prompted by a quest for better genes, then dispersal of the juveniles should not make a difference in extra-group paternity rate. But if it was driven by the need to minimize inbreeding, then it should. For the stay-at-home types, the pool of potential mates would include a high proportion of close, genetically-similar relatives. For birds that disperse each generation the pool of mates would be comparatively larger, more genetically diverse, and less likely to contain close relatives. The risk of inbreeding would be reduced, so the genetic benefits of promiscuity would also be reduced.

As it turns out, dispersal does make a difference. Durrant and Hughes found that among the non-dispersing western



Australian Magpies:  
Flings on the Wing



Scientists Shed Light  
on Mosquito  
Introductions  
Worldwide



Ants are Their Own  
Best Medicine



Most Stars are Single

magpies extra-group paternity accounted for a whopping 82% of the young. But for the white-back magpies the figure was reduced by almost half—just 44% of the young.

Durrant and Hughes put the “good genes” hypothesis to a further test. According to the hypothesis, females whose mates were already a source of good genes would have little to gain from seeking new partners. By the same token, high quality males would be less likely to be cuckolded than those of lower quality. Durrant and Hughes trapped and measured the male white-backed magpies of thirty-two social

groups, recording their size, weight, and parasite infestation as indicators of male quality. Comparing these factors with the genetic paternity of offspring in the groups, Durrant and Hughes were unable to find any significant correlation. High quality males were just as likely to be cuckolded as low quality ones.

Could it be that the females are looking for qualities other than those measured in the study? Maybe. But for now it appears that for Australian magpies looking for love, its variety, not necessarily quality, that adds the spice.



Australian Magpies:  
Flings on the Wing



Scientists Shed Light  
on Mosquito  
Introductions  
Worldwide



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Most Stars are Single



Studying mosquito introductions can provide insight into the spread of new and emerging diseases.

## Scientists Shed Light on Mosquito Introductions Worldwide

### Reference

Dina M. Fonseca, Julie L. Smith, Richard C. Wilkerson, and Robert C. Fleischer. Pathways of Expansion and Multiple Introductions Illustrated by Large Genetic Differentiation Among Worldwide Populations of the Southern House Mosquito *American Journal of Tropical Medicine and Hygiene*. 2006. **74**(2): 284-289.

As the threat of invasive species to our economy, environment, human health and even our security unfolds, the importance of understanding emerging disease organisms and their vectors is increasingly clear. In a study reported in the *American Journal of Tropical Medicine and Hygiene*, Dina Fonseca, Julie Smith and Robert Fleischer from the National Museum of Natural History Genetics Program, along with Rick Wilkerson of the Walter Reed Army Institute of Research at SI, are shedding light on one pervasive vector, the southern house mosquito, *Culex quinquefasciatus*.

The team focused on one of the best-known mosquito introductions: that of *Cx. quinquefasciatus* in 1826 to the Hawaiian Islands, where it is the sole vector of deadly avian malaria and a major vector of avian poxvirus. In 1823, when American naturalist T.R. Peale visited Hawaii, there were no mosquitoes. This species has spread with human expansion across the globe and is now everywhere in the world tropics and subtropics. The earliest records indicate that this mosquito was introduced to Hawaii from Mexico in 1826 by whaling ships replenishing their water barrels in freshwater streams on Maui.

The team performed a worldwide genetic

survey using powerful genetic markers in order to identify the source of the Hawaiian populations. Using DNA analyses on field-collected mosquitoes and five dried museum specimens from the Bishop Museum in Hawaii (collected between 1919 and 1944); they discovered divergent Old World and New World genetic signatures in *Cx. quinquefasciatus* with further distinctions between East and West African, Asian, and Pacific/Australian populations. These divisions correlate with the epidemiology of human filariasis, suggesting variation in vector-parasite compatibility.

This research revealed that the colder adapted South Pacific/Australian mosquitoes have largely replaced the original Mexican introduction of *Cx. quinquefasciatus*, which could explain in part the recent increases in elevational range in Hawaii. This replacement may not have occurred until around World War II, as no Pacific/Australian genes were found in museum specimens before 1944. The authors also found that in Hawaii there was evidence of multiple introductions and that most of the dozens of *Cx. quinquefasciatus* arriving monthly in Oahu via aircrafts appear not to reproduce-an important observation in the fight against invasive pest species.



Australian Magpies:  
Flings on the Wing



Scientists Shed Light  
on Mosquito  
Introductions  
Worldwide



Ants are Their Own  
Best Medicine



Most Stars are Single



*C. longiscapus* is covered with cavities that release bacteria produced antibiotics.

#### Reference

Cameron R. Currie, Michael Poulsen, John Mendenhall, Jacobus J. Boomsma, John Billen. Coevolved Crypts and Exocrine Glands Support Mutualistic Bacteria in Fungus-Growing Ant. *Science*. 2006. 311, 81-83.

## Ants are Their Own Best Medicine

Ants that tend and harvest gardens of fungus have a secret weapon against the parasites that invade their crops: antibiotic-producing bacteria that the insects harbor on their bodies. These fungal gardens are home to a parasitic microfungus (*Escovopsis*), which is capable of decreasing fungal growth rates, reducing worker ant production, and can even completely take over whole fungus gardens.

Smithsonian Tropical Research Institute researcher, Cameron Currie, with colleagues from the University of Wisconsin at Madison, University of Kansas, the University of Copenhagen, the University of Texas at Austin and the

Catholic University of Leuven, recently reported on a complex mutually beneficial relationship that has evolved in which the fungal gardens are protected from the parasite by antibiotic-producing bacteria, *Psuedonocardia*, that live in specialized body cavities on the gardening ants, who provide a home for the bacteria. The ants have specialized, highly adapted cavities in which the bacteria are housed and nourished with glandular secretions. In addition, closely related ants that do not grow fungus do not carry these bacteria and do not have the specialized body cavities. These findings are an indication that the ants, bacteria, fungus and parasites have likely been evolving together for tens of millions of years.



Australian Magpies:  
Flings on the Wing



Scientists Shed Light  
on Mosquito  
Introductions  
Worldwide



Ants are Their Own  
Best Medicine



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This artist's conception shows a rocky planet orbiting around a red dwarf star. Such planets may be more common than astronomers realized, since single red dwarfs are the most abundant stars in the galactic disk. Credit: ESO

## Most Stars are Single

### Reference

Charlie Lada. Stellar Multiplicity and the IMF: Most Stars are Single. 2006. *The Astrophysical Journal* (in press).

How many stars are twins? Astronomers know that more than half (about 57%) of all stars like the Sun are part of multiple systems—binary stars or even triplets that orbit around one another. Most likely they were born in these multiplets. This characteristic of stars not only holds clues as to how stars like the Sun were born, it reveals something about the conditions that prevailed when planets form. If, for example, orbiting binary stars tend to disrupt the formation of any planets around them, then our Sun's family of planets might be a rarer phenomenon than currently envisioned.

Smithsonian Astrophysical Observatory astronomer Charlie Lada has completed a new study of stellar multiplicity, and concluded—contrary to the conventional wisdom of a decade ago—that most stars now in the stable, long-lived portion of

their lives (the main-sequence stars) are single, not multiple. By reviewing and analyzing the current literature on star formation, he found two key facts that prompted this about-face. The first is that most stars in our galaxy are not like the Sun, but are much less massive; indeed, most stars in the galaxy have less than about one-half of the Sun's mass. The second observation is that these smaller stars appear in multiple systems much less frequently than their more massive cousins—perhaps only a third of them are in binary systems, not the ~60% for Sun-like stars. As a result, about two-thirds of all main-sequence stars are single. The findings mean that some process (or processes) during star formation tends to make many bigger stellar twins than smaller ones, perhaps related to the way their natal material fragments or rotates—intriguing subjects for future research.



Australian Magpies:  
Flings on the Wing



Scientists Shed Light  
on Mosquito  
Introductions  
Worldwide



Ants are Their Own  
Best Medicine



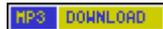
Most Stars are Single

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