RESEARCH NEWS

Mom vs. dad: Outcomes of genomic imprinting

When mom’s and dad’s genes compete, whose alleles prevail to make their progeny tall or give her big bones – and more important, why – is a matter of intense interest among evolutionary biologists.

Imprinting, the conditional (on which parent donated it) expression of a gene in an individual, accounts for much of the evolutionary change not adequately described in classical genetic theory. But scientists don’t yet have a solid framework for studying the evolutionary role, or long-term outcomes, of genomic imprinting.

The dominant explanation, at least since David Haig published it in 1991, has been “parental conflict hypothesis,” often referred to as kinship theory. Haig’s theory argues that imprinting is a consequence of opposing selection pressures on maternal and paternal genomes within an individual.

In other words, mom’s genes express in developing offspring for the good of her entire brood – perhaps by conserving resources for the mother so she can reproduce again – while dad’s express to make his individual offspring as fit as possible – by hogging maternal resources, for example.

Although most scientists accept kinship theory as a working principle, with just two decades of empirical study behind it, it hardly takes its place among the stalwarts of evolutionary theory.

“Just how prevalent imprinting is among mammals is still controversial,” says SFI Omidyar Fellow Jeremy Van Cleve. “Even murkier is the question of how much new theory is required to account for known cases of imprinting.”

In February Jeremy and SFI Professor Jon Wilkins hosted a three-day working group at SFI to take stock of recent experimental and theoretic advances in kinship theory, and to examine situations that seem to fall outside its struggle-for-maternal-resources manifestation.

These special cases, Jon says, provide an opportunity to test the potentially broader explanatory power of the kinship theory.

In one such case, detailed in a recent study published in the American Naturalist, Jeremy, SFI Science Board member Marcus > more on page 2

RESEARCH NEWS

At least for Aleuts, switching foods helps stabilize food web

A first-ever effort to quantify where humans fit in the food webs around us suggests a strategy for minimizing our negative effects on the natural world.

SFI Professor Jennifer Dunne and a team of archaeologists and ecologists from Idaho State University are studying Sanak Island, Alaska, where Aleut people lived for 5,000 years before recently moving to the mainland.

Using interviews, ecological observations, and archaeological studies, the team is reconstructing marine and terrestrial food webs for the entire Sanak archipelago. These complex ecological networks describe “who eats whom,” including humans, among the hundreds of species in local habitats. Surprisingly, such a “whole system” study of the human roles in a food web has never been done, Jennifer says.

Jennifer’s initial network analyses show that the Sanak Aleut were “super-generalists” and “super-omnivores” who ate a greater variety of plants and animals throughout the food web than other consumer species. In > more on page 2

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RESEARCH NEWS

Rhythmic fight schedules tap out social beat

Whether between friends or nations, conflict seems to come in waves. In a recent paper, three SFI researchers suggest that various types of conflicts also tend to occur on regular schedules.

Omidyar Fellow Simon DeDeo and Professors David Krakauer and Jessica Flack analyzed 150 hours of observations Jessica had collected on patterns of conflict in a monkey society to see if monkeys learn better strategies as they gain experience fighting.

Rather than the simple learning trends the trio expected, however, they discovered evidence for a “conflict clock” – a social version of biological clocks like circadian rhythms – that predicts when animals will fight. > more on page 4

INSIDE SFI

Report: SFI ranks 8th among world’s science think tanks

SFI ranks 8th among the world’s foremost science and technology think tanks, according to a recently released annual report by the University of Pennsylvania’s International Relations Program.

Nearly 5,500 think tanks were nominated in 29 categories. Some 1,500 scholars, journalists, officials, and donors from 120 countries participated in the ranking process.

“This is certainly a great honor,” says SFI President Jerry Sabloff. “As a theoretical research center dedicated to the sciences of complexity, SFI is not a think tank in the traditional sense. However, as we gain insights into the complex systems most critical to our > more on page 2
Symbolic dynamics and synchronization of coupled map networks with multiple delays; Abay, P.M., Jalan, S.; Juergen Jost; Physics Letters A 375 (2), December 1, 2010

Living on the edge of chaos: Minimally nonlinear models of genetic regulatory dynamics; Hainel, R.; Pichacker, M.; Stefan Thurner; Philosophical Transactions of the Royal Society A-Mathematical, Physical, and Engineering Sciences 368 (1933), December 28, 2010

Hydraulic trade-offs and space-filling enable better predictions of vascular structure and function in plants; Van Savage; Bentley, L.P.;

Berteskas,

Juergen Jost

Evolutionary innovations and the organization of protein functions in genome space; Ferrada, E.; Andreas Wagner; PLOS One 5 (11), November 30, 2010


RESEARCH NEWS

Study: How to create a living computer

Biological systems with decision-making ability can be created using multiple combinations of cells modified by genetic engineering, according to a study published in Nature by a research team led by SFI External Professor Ricard Sole (Universitat Pompeu Fabra, Barcelona, Spain).

The work opens the possibility of distributing biological "computations" over multiple cells that perform different logical functions and communicate with one another through signaling molecules that serve as chemical "wires." The ability to divide computations among different cells means the cells can be used to build circuits analogous to those in electronics.

"We can use [cells] in a combinatorial way," says Ricard. "Potentially we can generate thousands of different circuits and so implement thousands of different functions."

The researchers published their results online in Nature on December 8. Ricard is the corresponding author.

> Food webs continued from page 1

The intertidal food web, for example, Sanak Atuats are more than a quarter of all species at all levels of the web. Historical and archeological records show that the Atuat also regularly switched what they ate, by hunting sea lions when the weather was good, harvesting salmon when they migrated up the local river, or digging for clams when other food items were unavailable or inaccessible.

Switching made sense – if one thing gets hard to find, eat another – but also helped keep the ecosystem healthy by giving plant and animal populations a chance to recover. Jennifer’s modeling demonstrates the importance of this behavior: a super-generalist can be part of a stable ecosystem as long as they eat only a few species at a time, she says.

In the modern world, economic pressures can interfere, however. She cites blue fin tuna, which have been in the news recently because their value has skyrocketed as they have become rare due to over-fishing for the sashimi market. People’s failure to switch to other more available, but less profitable, species is driving blue fin tuna towards extinction.

Jennifer says this cycle also, and more alarmingly, introduces a potentially destabilizing dynamic: ripple effects in the food web could drive other species to extinction, altering the ecosystem’s fundamental structure and function and ultimately affecting what – and how – much food we humans have left.


Optimal viral strategies for bypassing RNA silencing; Rodrigo, U.; Carrera, J.; Jaramillo, A.; Santiago Elena; Journal of the Royal Society Interface 8 (55), February 6, 2011

The extensibility of programmable hardware; Raman, K.; Andreas Wagner; Journal of the Royal Society Interface 8 (55), February 6, 2011

Genomic imprinting continued from page 1

Feldman (Stanford), and Laurent Lehmann (University of Neuchatel) modeled over many generations the evolution of traits in a notional population of males and females.

They found that minor demographic variables – such as small differences in male-to-female ratios and frequency of movement among individuals – seem to play important roles in which genomes dominate, at least on evolutionary time scales.

“We suggest that the evolution of imprinting, within the context of kinship theory, can arise from demographic conditions in a population,” says Jeremy.

At the meeting a small group of collaborators began to develop a framework for what outcomes kinship theory should predict, which will be useful for designing future tests of the theory. The meeting is expected to result in a review paper for the journal Trends in Genetics.

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The SFI Update is published b-monthly by the Institute to keep its community informed. Please send comments or questions to John German at jgd@santafe.edu.

Follow SFI online at www.santafe.edu

The Banak intertidal food web. Yellow lines indicate feeding relationships – who eats whom – among the 176 taxa. (Image: Jennifer Dunne)
Florian Cajori and his colleagues at the United States Bureau of Labor Statistics

Censorship has long been a challenge to the dissemination of information, but the rise of the internet and social media has added a new layer of complexity. In a talk at the 2011 Sustainability School in Brunei, SFI Professor Jennifer Dunne responded to a question about the role of censorship in the digital age:

"Constantly scaling our programs by way of new formats, new venues, and new audiences is all about building a sustainable educational pipeline for today's and tomorrow's complexity scholars," adds Ginger. "Learning technical and computing skills will give young people the background needed to succeed in these fields," says Lenore Lo, principal investigator for GUTS y Girls, which will provide extramural curricula for some 300 middle school girls.

Once-a-month Saturday workshops in Santa Fe will offer girls the opportunity to meet women scientists and professionals, participate in hands-on projects, and learn about career options. Two-week summer workshops are being held in Santa Fe, Albuquerque, and Las Cruces.

The program is an outgrowth of the successful 4-year-old, SFI-led Project GUTS (Growing Up Thinking Scientifically), an after-school program designed to encourage young people to ask questions about issues that affect their communities, investigate them through scientific inquiry, and devise potential solutions by modeling and analyzing them as complex systems.

GUTS y Girls includes a research component. Because girls tend to succeed when they see others like them succeeding, the program enlists women scientists as mentors and keeps girls and their mentors connected through a private social networking site. The research will investigate whether these activities promote and sustain girls' interest in science and math over time.

The program is a collaboration among SFI, MIT, the University of New Mexico, New Mexico Tech, New Mexico State University, the Santa Fe Complex, the Girl Scouts of New Mexico Trails, the Supercomputing Challenge, and New Mexico schools.

INSTITUTE SFI

2011 sustainability school in Brunei

The Universiti Brunei Darussalam (UBD) is hosting the 2011 Global Sustainability Summer School in Bandar Seri Begawan, Brunei, co-sponsored by IBM. Although SFI is not a sponsor for the 2011 school, the structure, topics, and lectures for the will be similar to the previous schools held at SFI. It is being organized by Condra Sceharam, an alumni of SFI's sustainability school.

The 2012 school is expected to be held in Germany, at the Potsdam Institute for Climate Impact Research.

For more information about the 2011 school, visit www.sustainability2011.org.

INSTITUTE SFI

New GUTS y Girls engages tomorrow's women scientists

The National Science Foundation is sponsoring a three-year, SFI-led program designed to attract New Mexico girls to careers in science, technology, engineering, math, and information and communications technology – fields in which women are historically under-represented.

Wednesday, April 13 – Sending Secrets: Security and Cryptography In a Quantum World. The art of sending secret messages has come a long way since Julius Caesar shifted each letter three places in the alphabet. Much of modern computer science was born in the effort to break the Nazi Enigma code. Today we depend on cryptography, to send our credit card information over the Internet, for example. SFI Professor Chris Moore, professor of computer science, physics, and astronomy at the University of New Mexico, will describe how modern cryptosystems work, and how a future quantum computer could break them. He’ll then give a personal view about whether quantum computers can be built – and what kinds of cryptography could remain secure even if and when they are built. Underwritten by Joy and Philip LeCoyer.

Wednesday, May 18 – Can Financial Engineering Cure Cancer, Solve the Energy Crisis, and Stop Global Warming? The important lessons from the spectacular failure of financial technologies could pave the way for some of the most significant achievements of the 21st century. Andrew Lo, Harris & Harris Group Professor at the MIT Sloan School of Management and Director of MIT’s Laboratory for Financial Engineering, will provide a broad overview of the origins of the crisis, the key role that mathematics played, and how a deeper understanding of human nature may allow financial engineers to focus the enormous power of global financial markets on some of society’s most pressing challenges. Underwritten by Dr. Penselope Penland.

In SFI’s first 2011 community lecture on March 2, SFI Diplomat in Residence Bill Frey of USAID explored the transition from conflict to stabilization to sustainable development in Afghanistan. The lecture was underwritten by Diana MacArthur, an SFI Trustee.

For more information, see www.santafe.edu/events/
SFI's Orlando Montoya: Keeping the Institute humming for 17 years

Seventeen years ago when the first Institute scientists arrived at what is now Cowan Campus, Orlando Montoya was here. And he's been here ever since.

"I tell people I came with the house," he laughs.

Orlando makes possible the Institute's constant hum of activity by keeping the lights on, keeping the boiler running, and performing (with a smile) myriad other activities critical to SFI's smooth operation. He started working on the property in 1969, when it was owned by the family of Geo. Patrick Hurley, the former U.S. Secretary of War and New Mexico candidate for U.S. Senate.

Though he works half time, Orlando handles about 200 work requests per year. He is the expert on any repair, from plastering walls to unclogging sinks, and is on call for snow removal and maintenance emergencies. Ronda K. Butler-Villa, SFI's Director of Publications, Facilities, and Personnel, says he possesses the rare combination of general know-how and an intimate knowledge of the property and its history, as well as SFI's culture and people.

The property has been more than a workplace for Orlando; he and his wife lived in the gatehouse at the bottom of the drive for 10 years and raised two of their three children there. In heavy snow the driveway became a sled run, where his son and daughter spent hours hurting down the hill on inner tubes.

In his spare time Orlando enjoys restoring vintage cars. His current projects include a 1951 Ford Custom Victoria and a 1946 Ford pickup truck, which is often seen and appreciated at SFI.

RESEARCH NEWS

Certain airline networks are more resilient

Southwest Airlines' lack of a hub-and-spoke network makes it more resilient to a number of disruptions, from weather problems to terrorism. But it's easy to make the other airlines' hub-and-spoke networks more robust.

Using network simulations, SFI External Professor Raisa D'Souza and collaborators Daniel Wulffner and Soumen Roy, all of UC Davis, show that while hub-and-spoke networks are more economically efficient on good days, they are more susceptible to random interruptions (such as bad weather) and local interruptions (such as airport security shutdowns).

Flight networks with large, densely connected subnetworks called "k-cores" — like Southwest’s network — remain better connected when specific flights or airports are removed. Southwest's average travel time increased only 4 percent in the simulations after removing a targeted 10 percent of its network and its history, as well as SFI's smooth operation. He started working on the property in 1969, when it was owned by the family of Geo. Patrick Hurley, the former U.S. Secretary of War and New Mexico candidate for U.S. Senate. Although he works half time, Orlando handles about 200 work requests per year. He is the expert on any repair, from plastering walls to unclogging sinks, and is on call for snow removal and maintenance emergencies. Ronda K. Butler-Villa, SFI's Director of Publications, Facilities, and Personnel, says he possesses the rare combination of general know-how and an intimate knowledge of the property and its history, as well as SFI's culture and people.

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RESEARCH NEWS

Study: Phone communities coincide with political boundaries

Analyzing a database of 12 billion British telephone calls, three researchers affiliated with SFI have found that phone interactions among people coincided remarkably well with regional administrative boundaries established by governments. Their algorithm also detected a new "region" west of London, around a growing center of high-tech industry — the British version of Silicon Valley.

The research team included former SFI External Professor Steven Strogatz (Cornell University), former SFI postdoctoral fellow Michelle Girvan (University of Maryland), and SFI External Professor Mark Newman (University of Michigan).

 Communities and political boundaries probably evolved together over many centuries, the researchers suggested recently in Physical Review E.

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