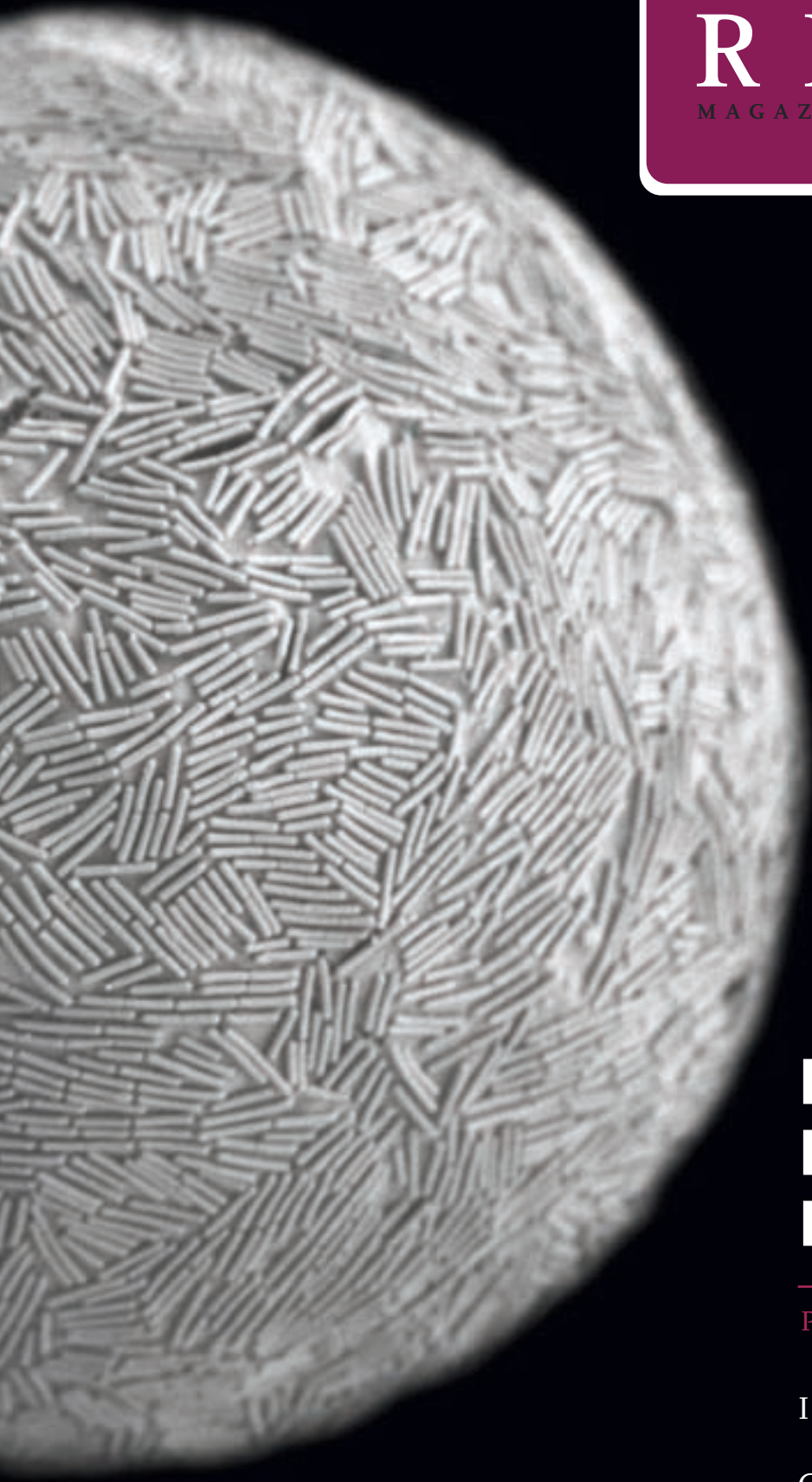


THE MAGAZINE OF THE
CANADIAN INSTITUTE FOR ADVANCED RESEARCH

REACH

MAGAZINE

WINTER 2012



MYSTERIOUS MICROBIAL MATTERS

PLUS

INSIDE A NEWBORN'S BRAIN

CLIMATE CHANGE AND
HUMAN EVOLUTION

REACH

MAGAZINE

Winter 2012

Volume 12, Issue 1



CIFAR

CANADIAN INSTITUTE
for ADVANCED RESEARCH

Creating knowledge that expands human possibilities.

CIFAR is a Canadian non-profit research institute that has been changing the world of research and building Canada's research capacity for 30 years. Today, our researchers are working on big questions with the potential to improve human health and the environment, transform technology, build strong societies, understand human culture and even chart the universe.

Nearly 400 researchers in 16 countries participate in our long-term, multidisciplinary and collaborative advanced research teams. CIFAR is supported by exceptional individuals, foundations, corporations, the Government of Canada and the provincial governments of Alberta, British Columbia and Ontario.

ON THE FRONT COVER

An image of a protist covered in bacteria, captured by using a scanning electron microscope. It's just one of the "complex and beautiful" micro-organisms being studied by CIFAR's Patrick Keeling and colleagues. Protists represent the most varied and largest group of eukaryotes (cells that have a nucleus). In this particular instance, Dr. Keeling wants to understand why bacteria coat the protist "like a rum ball".

Photo credit: Kevin Carpenter and Patrick Keeling

CONTENTS

- 1 An extraordinary global gathering
- 2 In memoriam / Briefs
- 3 CIFAR researchers in the news
- 5 Shining a light on microbial mysteries
- 8 Inside a newborn's brain: what babies know about language
- 10 Climate change and human evolution: peering into the past
- 12 Broadening horizons for promising scholars
- 15 Investing in the future
- 16 CIFAR Lunar Circle
- 17 CIFAR Donors
- 20 CIFAR Board of Directors

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AN EXTRAORDINARY GLOBAL GATHERING

Thousands of people from around the world are converging on Vancouver in February 2012 to attend the Annual Meeting of the American Association for the Advancement of Science (AAAS) – and CIFAR is there.



For the first time in 30 years, Canada is hosting this extraordinary meeting of researchers, policy-makers, educators and journalists who come together every year to share new findings and discuss global challenges. CIFAR

researchers are well represented on several panels and this issue of *Reach* magazine is rich with some of their stories.

We feature the work of biologist and Fellow Patrick Keeling. Using powerful new techniques to peer at the microbial world, Dr. Keeling is making discoveries about microscopic protists – mostly single-celled organisms that are big players in sustaining life on Earth.

We also profile Janet Werker, a psychologist and Fellow who is shedding new light on how we acquire language. It happens much earlier than you might think. Dr. Werker's research shows that even in the first days of life, newborns respond differently when they hear familiar versus unfamiliar languages.

Mark Collard, an archaeologist, is working with climate scientists to better understand how the Earth's changing climate has shaped human evolution. As you will read, this knowledge may have huge implications for understanding how our environment could affect humans in the future.

The AAAS and CIFAR share a deep commitment to the career development of researchers. This issue of *Reach* profiles the research and leadership opportunities at CIFAR's Junior Fellow Academy, and spotlights three of our outstanding Junior Fellows.

As we continue to mourn the loss of Fraser Mustard, intellectual entrepreneur and CIFAR founder, we celebrate his vision for a global institute that promotes interdisciplinary, inter-university research and explores the scientific and social challenges important to Canada and the world. Most fitting for this AAAS issue, we begin with a tribute to a man who welcomed the world to Canada and gave researchers from around the globe an intellectual home at CIFAR.

A handwritten signature in black ink that reads "Chaviva Hošek". The signature is written in a cursive, flowing style.

Chaviva M. Hošek, O.C.
President and CEO and
Lawson Foundation Fellow

IN MEMORIAM

Celebrating the life of CIFAR's founding father Fraser Mustard



Canadians mourned the passing of Fraser Mustard last November. A remarkable man, Dr. Mustard was the Institute's founding

president for its first 14 years.

Throughout his life, he was an active member of CIFAR's research community.

Fraser wanted nothing less than to create a global institute to foster interdisciplinary research and explore scientific and social challenges facing

Canada and the world. He made an enormous contribution to our understanding of how social and economic gradients affect health, early child development and lifetime well-being. In his later years, his passion grew for research into how to create true equity in human development, which he believed should be a goal for all countries and communities.

To celebrate his profound legacy, CIFAR has established the **Fraser Mustard Fund**.

The fund enables researchers to explore topics that inform our understanding of equity in human development.

Researchers are working on important questions such as what makes some societies healthier than others, how do experiences and settings affect developmental biology and set trajectories for life-long health, and what makes some countries better able to support their people in the face of multiple threats.

"Join with us and be inspired by Fraser's determination, curiosity and huge intellect," says CEO Chaviva Hošek.

For more information, contact Kara Spence, Vice-President of Advancement at kspence@cifar.ca or 416-971-4439.

BRIEFS

Incoming President and CEO Alan Bernstein, O.C. to start May 1, 2012



Dr. Alan Bernstein commences his term as the Institute's new President and CEO on May 1, 2012.

"Alan is a visionary leader who has a wealth of experience guiding pioneering enterprises that conduct leading-edge research and promote interdisciplinary collaboration, just like CIFAR," said CIFAR Chair David Dodge. "It's great to have him back in Canada."

Most recently, Dr. Bernstein was executive director of the Global HIV Vaccine Enterprise in New York, an

international alliance of researchers and funders charged with accelerating the search for an HIV vaccine.

From 2000 to 2007, Dr. Bernstein served as the inaugural president of the Canadian Institutes of Health Research, Canada's federal agency for the support of health research, where he led the transformation of health research in Canada.

To read Dr. Bernstein's complete bio, please go to www.cifar.ca.

CIFAR RESEARCHERS IN THE NEWS

CIFAR researchers are making headlines around the world.
Here's a sampling of recent coverage:



DEUTSCHE WELLE

The long learning curve of the European Union

The European debt crisis is causing worldwide anxiety. CIFAR's **Peter A. Hall** of Harvard University believes that economic myths present since the inception of Europe's Economic and Monetary Union have contributed to the debt crisis. In an online article written for Germany's *Deutsche Welle*, Dr. Hall argues that the crisis has shattered many of those founding myths, such as the one holding that the European Central Bank should only concern itself with inflation.

But more of these myths need to fall for the Eurozone to recover, he says. Dr. Hall discusses the need for a coordinated fiscal policy and a central bank that manages sovereign debt. He also argues that structural reform is no substitute for a real growth strategy. Fast changes are needed if Europe hopes to resolve the crisis and restore economic growth.

THE TORONTO STAR

What happens when you place two wires only 150 atoms apart?

Scientists have created one of the world's smallest electronic circuits made up of two wires only 150 atoms apart. The team, led by CIFAR's **Guillaume Gervais** of McGill University and Mike Lilly from the Center for Integrated Nanotechnologies at Sandia National Laboratories, discovered that current in one wire can produce a strong and unexpected effect in the second wire. "They talked in an awesome way," Dr. Gervais told *The Star*. "Imagine if you flow a current in one of them, a transient current will develop in the other or, in other words, a voltage spontaneously appears in the second wire.

Sometimes the induced current moved forward, and sometimes it moved backwards." The team was surprised to find that the induced voltage was as large as 25 per cent of the input voltage in these nanoscale circuits. The findings could have great potential for understanding electrical circuitry at the nanoscale, so as to improve the speed and power of electronic circuits used in technologies such as smartphones and desktop computers. The team's findings were published in the journal *Nature Nanotechnology*.

Bushmeat feeds hungry: study

Endangered wildlife meat and childhood anemia are a complex issue in remote areas of the world. Bushmeat is a source of iron, which is an essential component of hemoglobin. And research shows that children who eat bushmeat are less likely to suffer from anemia, which can impair growth and development. CIFAR's **Lia Fernald** of UC-Berkeley was part of a team that ventured into a remote region of Madagascar, where the local population relies heavily on wildlife for food, including several endangered species like lemurs.

The team found that if the population they studied lost access to wildlife as a source of food and other measures were not taken, anemia in children would increase significantly. *National Geographic News* describes how these research findings have significant implications for conservation laws and children's health around the world.

What's in a name? A job, maybe



Having an English-sounding name gives you an edge when looking for work, new findings show. Researchers sent out thousands of fictitious résumés in response to job postings in Vancouver, Toronto and Montreal and found that job applicants with English-sounding names were more likely to receive a callback, even when their skills were the same as their non-Anglo counterparts.

Philip Oreopoulos, a Scholar in the *Social Interactions, Identity and Well-being* program, led the study with PhD student Diane Dechief, both at the University of Toronto.

Early struggles help shape DNA

Early childhood experiences leave a lasting print on our DNA. Research by CIFAR's **Clyde Hertzman** at the University of British Columbia and **Moshe Szyf** at McGill University found a link between socio-economic environment in early life and variation in an individual's DNA. This biological embedding may explain why some of the health disadvantages linked to lower socio-economic status, like obesity, can last a lifetime even when this status has improved.

As reported in *The Gazette*, the researchers looked at one type of DNA change called methylation. They found that the socio-economic environment experienced in early childhood has a greater impact on an adult's DNA methylation, compared to the environment in adulthood. The next step is to understand how these DNA changes affect an individual's health. The team's findings were published in the *International Journal of Epidemiology*.



As *The Globe and Mail* reported, the researchers spoke with recruiters and found that employers were concerned about inadequate communications skills. Dr. Oreopoulos and Dechief suspect implicit ethnic discrimination is involved. This research has a potential to change the way employers recruit applicants for interviews. The findings come out of a working paper produced for the Metropolis British Columbia Centre of Excellence for Research on Immigration and Diversity.

SHINING A LIGHT ON MICROBIAL MYSTERIES

BY MARGARET POLANYI



In the ocean off Australia's coast lies one of the world's greatest playgrounds for sea creatures, micro-organisms and humans. The Great Barrier Reef and the currents that swirl around it are teeming with something known as protists: mostly single-celled microbes. "They are incredibly complex and beautiful organisms with amazing shapes, symmetries and behaviours," says CIFAR Fellow Patrick Keeling, a biologist and protistologist at the University of British Columbia.

So it's not surprising that when he travelled to a meeting in Australia recently, Dr. Keeling packed a wetsuit and microscope. The objects of his fascination are generally too small to see with the naked eye, but they are ubiquitous. "They're in our bodies, the soil, the lakes and rivers, the air," says Dr. Keeling. "They get into every single ecosystem imaginable. If we didn't have them around, our ecosystem would collapse." Protists take up carbon dioxide from the Earth's atmosphere and release oxygen. They pump essential nutrients into the water and play an important role in the food chain. They are integral to many industrial processes.

Protists represent the most varied and largest group of eukaryotes (cells that have a nucleus), a group that includes all animals, plants and fungi. Yet, until recently, most of their diversity remained undiscovered. "For most of human history, we didn't notice that they existed," says Dr. Keeling, director of CIFAR's *Integrated Microbial Biodiversity* program.

One of the reasons: studying protists is complicated. "When you study giraffes, you can go out and find a giraffe. But if you're studying microbes, the cell and organism are the same thing, so you have to work at the cellular level." The usual way to study cells involves growing large numbers from a single cell. But most protists can't easily be cultivated in a Petri dish because it's almost impossible to mimic their complex environment.



Emiliana huxleyi: this protist is a common marine alga that takes up carbon dioxide from the atmosphere and releases oxygen.

Image credit: J. Young, Natural History Museum, London

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We can now sequence whole genomes from a single cell that can't be grown in a lab.

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However, thanks to recent technological advances, we can now meet protists face to face. Breakthroughs like single-cell genomics and high through-put DNA sequencing are providing deep insights into their world. “We can now sequence whole genomes from a single cell that can't be grown in a lab,” says Dr. Keeling. Almost 20 years ago, Dr. Keeling entered this field as a PhD student of CIFAR Fellow Ford Doolittle of Dalhousie University.

Using powerful molecular techniques, Dr. Keeling has made exciting discoveries. Working with CIFAR Scholar Claudio Slamovits, he found a marine protist known as *Oxyrrhis marina* that robs its prey of a gene that promotes photosynthesis. It seems the predator may be using the stolen gene to generate energy from sunlight – or using sunlight to digest its food. “That would be a novel use of light as an energy source,” says Dr. Keeling.

Right now, his lab is puzzling over a curious relationship between protists and bacteria that live together in the guts of wood-eating insects. The bacteria coat the protists “like a rum ball”. Dr. Keeling theorizes that “they must be exchanging some type of nutrient, that they have some cooperative agreement.”

As new protists, lineages and relationships are identified, Dr. Keeling and CIFAR colleagues are contributing their findings to the Tree of Life Web Project, a massive repository for all scientific knowledge about the diversity, evolutionary history and characteristics of every species and significant group of organisms on Earth, living and extinct.

And the tree is looking very different these days. “Fifty years ago, we drew the tree with animals and plants as the two largest parts. The protists were somewhere at the bottom,” explains Dr. Slamovits, who studies protist genomes at Dalhousie. “Now, it's the opposite. Animals are a tiny branch and so are plants. And they are part of a huge bush with thousands of branches and leaves where almost everything is protists.”

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Microbiologists are today doing for biology what Copernicus did for cosmology. We're removing ourselves from the centre of the universe.

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Patrick Keeling on his recent trip to Australia.

“Microbiologists are today doing for biology what Copernicus did for cosmology,” says Dr. Keeling. “We're removing ourselves from the centre of the universe.”

Studying protists can also shed light on the origin of diseases, adds Dr. Slamovits, organizer of a 2012 AAAS symposium about microbial diversity. Some protists cause human infections, such as malaria, while others lead to diseases that affect poultry, cattle and fish. Just a few years ago, a startling discovery by Dr. Keeling's team and Czech CIFAR Associate Dr. Julius Lukeš connected malaria and the algae responsible for toxic red tides to a common ancestor.

There's still much to learn about microbial diversity—even as human activity threatens it. Dr. Keeling cites a Dalhousie study that used oceanographic data to show that microbial diversity has been declining at about one per cent each year for the last 100 years. “If you do the math, it comes out to about half of what it used to be.”

Just look at “coral bleaching” which makes coral die in places like the Great Barrier Reef. It happens when protists are ejected from coral cells.

“There are no protists on the Red List of Threatened Species but loads are probably endangered because every time an animal goes extinct, there are perhaps 20 microbes that go extinct with it,” says Dr. Keeling.

All of which adds an extra urgency to this research.

INSIDE A NEWBORN'S BRAIN: WHAT BABIES KNOW ABOUT LANGUAGE

BY MARGARET POLANYI



When we hold a newborn, our attention is usually drawn to the delicate features, the tiny fingers and toes, the soft burbling. But there's much more going on than meets the eye. The latest research shows that from the moment they are born, babies are picking up on language in the most extraordinary ways.

"They are primed for language and have already started learning about their native language at birth," says Dr. Janet Werker, a CIFAR Fellow and professor of psychology at the University of British Columbia. Dr. Werker studies the factors that help a child acquire language, especially in the first two years of life. She's widely respected for her dazzling insights into how finely tuned the infant brain is to language.

But until now, few researchers had ever tested newborns aged zero to three days to see what's actually going on in their brains as they listen to language. In a fascinating study published online in *Frontiers in Psychology* in September 2011, Dr. Werker and her collaborators did just that. They wanted to see how speech heard by babies in the womb might shape their brain's response to language in the first few days of life.

The team looked at the neural response of 20 newborns of English-speaking mothers when the infants were exposed to both English and an unfamiliar language. The researchers measured changes in the oxygen levels of neural blood as they shone an infrared light at the baby's head while the infant was asleep or at rest in a bassinet. Intriguingly, when newborns listened to familiar and unfamiliar language, there was a clear difference in brain response.

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These results show that even prior to birth, the human brain is tuning to the language environment.

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“These results show that even prior to birth, the human brain is tuning to the language environment,” says Dr. Werker. “The fact that brain activity was greatest when babies heard their native language suggests that prenatal experience – in addition to biological programming – seems to have an impact at this early stage of life.”

It’s amazing to think that babies experience language in utero. How does this work? The peripheral auditory system (the outer, middle and inner ear) is developed by 26 weeks gestation. “The mother speaks and the sound goes to the belly and makes the amniotic fluid vibrate and that hits the ear drum,” explains Dr. Werker. The fetus is also exposed to the mother’s speech through bone conduction. The rhythmical properties of language come through most strongly, says Dr. Werker. Meanwhile, the brain is developing and organizing. “It’s more developed at 40 weeks than it is at 26 weeks. Some of this is probably determined by the maturation process, but there is also an opportunity for auditory input to have a role in organizing the area of the brain that processes language.”

Understanding prenatal language experience is not easy, considering the study subjects. “The problem with babies is that they do not listen to instructions,” Dr. Werker says with a laugh. Babies get irritable and distracted. They get hiccups and gas. A lot of wriggling can throw off sensitive equipment. Even so, Dr. Werker’s team is learning new things every day – including about the roots of bilingualism.

Her team has shown that infants just zero to five days old and born to monolingual English mothers prefer only English. By contrast, babies of bilingual English-Tagalog mothers show a preference – by sucking more intensely on their pacifiers – for both English and Tagalog. “Babies who are exposed to two languages even in utero are already responding to both of their native languages within hours of birth,” says Dr. Werker. (Interestingly, without continued exposure to both languages, babies will later lose interest in the less used language.)

“I don’t want the message to be that prenatal listening experience is entirely responsible for driving language acquisition – because I think the brain has to be prepared for the input it’s going to receive – but clearly experience can start having an effect as soon as the information is coming in.”

So should women be reciting Shakespeare to their pregnant bellies to enhance the auditory experience inside the womb? Dr. Werker thinks not. “In most cases, babies are getting enough input naturally.” But she’s intensely interested in learning how much prenatal language experience is enough to shape the neural response to language.

Another question: what happens to language development when pregnant women take certain medications? At the 2012 AAAS meeting, Dr. Werker, with CIFAR’s Dr. Takao Hensch of Harvard University, will present important new findings from a study that examined the effect on prenatal language development when pregnant women took common anti-depressants. Dr. Werker is chairing a AAAS symposium centred on the effects of early experience on lifelong functioning – a key area of inquiry for CIFAR’s *Experience-based Brain and Biological Development* program, to which Drs. Werker and Hensch belong.

“As a human species, language is one of our most quintessential capabilities. My interest is in understanding the critical periods in language acquisition, the role experience plays in organizing the brain, and the lasting effects.”

CLIMATE CHANGE AND HUMAN EVOLUTION: PEERING INTO THE PAST

BY VERONIKA BRYŚKIEWICZ

Discussing the weather might be the stuff of small talk, but changes in the Earth's climate have been linked to humanity's evolution and migration patterns. In the last quarter of a million years – the period in which modern humans appeared and spread around the globe – climate has changed frequently with cold spells lasting hundreds of years, interspersed with periods of warming. However, the last 10,000 years have been relatively stable, allowing human civilization to flourish and agriculture to evolve.



Mark Collard: combining skills in archaeology, palaeontology and anthropology

Although many scientists believe that climate is one driver of human evolution, it's only recently that researchers have begun to be able to quantify the impact of climate change on humanity, says Mark Collard, a professor of archaeology and Canada Research Chair at Simon Fraser University. A member of the steering committee for a series of CIFAR collaborative research workshops in this new area, Dr. Collard is peering into our past to find links between climate and changes in human behaviour.

“Currently, we are going through a major rise in temperature around the globe,” says Dr. Collard. “We are not entirely sure what to do about it because we have limited experience dealing with such changes. By looking to the past, we can learn how previous changes in climate affected humans, and what we can expect in the future.”

Combining his skills in archaeology, palaeontology and anthropology, Dr. Collard is exploring several instances of climate-related population shifts. One current project he is carrying out with one of his graduate students, Christopher Carleton, centres on a mystery surrounding a well-known Neolithic dig site in Çatalhöyük, Turkey.

Inhabited between about 7,400 and 5,600 BCE, Çatalhöyük was one of the world's largest settlements at the time. Archaeological evidence suggests that people living in one area of the site suddenly abandoned it around 6,200 BCE. But why did this happen? And why, later, did people move into the vicinity but choose to live on the other side of the river?

Archaeologists suspect that climate may have played a role. Climate scientists know that around this time, the area became dry and cool, making it hard to sustain agriculture. But then something else apparently changed, attracting new people close by.

Dr. Collard and Carleton are developing a methodology to test whether climate was the cause of the settlement's abandonment and later reinhabitation. To test this theory will require archaeological data – and the latest tools of archaeology and palaeontology, such as stable isotope analysis, which helps to characterize potential source materials and their chemical elements.

Archaeological work of this kind is often informed by the expertise of climate scientists like Andrew Weaver, a professor at the University of Victoria. Dr. Weaver was a lead author in the UN Intergovernmental Panel on Climate Change, which was awarded, with former U.S. Vice President Al Gore, the 2007 Nobel Peace Prize.



Mystery surrounds this Neolithic dig site in Çatalhöyük, Turkey.

Drs. Collard and Weaver are both part of a wide-ranging group of experts who have been involved in CIFAR's exploratory workshops investigating how best to develop a scientific framework to better understand human-environment interactions.

As a climate scientist, Dr. Weaver uses the language of mathematics, along with high-powered computing, to model the interaction between climate and the biosphere over time. "By examining data from many archaeological sites, we can develop testable hypotheses about why people left one part of the world, and moved somewhere else," he says.

Dr. Collard is also leading a panel at the 2012 AAAS that will explore climate change over the last seven million years. It will consist of an interdisciplinary mix of researchers ranging from palaeo-environmental experts to researchers in human evolution and anthropology. What the panel plans to present are the first steps in figuring out how to quantify research in this new area of interdisciplinary exploration.

"As modern humans, we have no experience in dealing with major shifts in climate," says Dr. Weaver. "But as the Earth gets warmer, this is what we are trying to figure out."

BROADENING HORIZONS FOR PROMISING SCHOLARS

BY MARGARET MROZIEWICZ



On a fresh spring day last April, a group of early-career researchers from fields as diverse as cosmology, microbiology and sociology gathered at a Toronto hotel for a meeting of the Junior Fellow Academy – CIFAR’s elite leadership development program.

Over the course of two days, no field went unexplored as Junior Fellows presented their work to each other. Questions were asked about how different disciplines approach their research. Suggestions were made about how to interpret findings differently. Conversation spilled into the corridors at coffee breaks. The imaginative wheels were turning.

Intellectual dynamism is central to the Junior Fellow Academy, which is designed to provide unparalleled leadership and learning opportunities for people who have shown outstanding scholarship and research potential. Most are postdoctoral fellows at a university or a research institute, while those in the social sciences may be junior faculty members.

For Mel Silverman, Vice-President of Research at CIFAR, the Academy is about building thoughtful leaders who are connected to Canada throughout their careers. “We are creating a long-lasting network of scholars. We hope that fifteen years from now they will continue to trust and work closely with one another.”

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A unique feature of the program is that each Junior Fellow is embedded in one of CIFAR’s interdisciplinary research programs, working under the mentorship of one of the Institute’s world-leading researchers. Welcomed as full program members, Junior Fellows work collaboratively with internationally renowned investigators from diverse fields.

Since the program began in 2008, Junior Fellows have published over 120 papers in peer-reviewed journals. Some Fellows have already been recognized with awards and honours and our Alumni have an outstanding success rate when it comes to landing research positions either in academia or business.

With its special opportunities for mentorship and collaboration, the Junior Fellow Academy attracts applicants from all over the world. In fact, 56 per cent of the Junior Fellows to date were living outside of Canada when they applied for their fellowship. At full capacity, the Academy has 24 Junior Fellows.

For Mel Silverman, it’s about creating a new generation of academic, business and government leaders who excel at thinking outside of the box. “At the end of the day, we hope to broaden horizons and accelerate the international career path of these gifted scholars.”

Junior Fellowship positions within each program become available at different times. To find out more, visit cifar.ca/junior-fellow-academy.

JUNIOR FELLOW PROFILES



ARJUMAND SIDDIQI

Health research “far from the norm”

Arjumand Siddiqi studies the social well-being of communities and societies. During her time in the Academy’s first cohort of Junior Fellows, she shed light on health inequities between countries – an understudied area of research.

Dr. Siddiqi says that being part of the Junior Fellow Academy in 2008-2009 enabled her to explore research questions “far from the norm” in her field of social epidemiology.

“It helped me to develop my thinking around novel and important points of intersection between my own work and research pursued by other researchers which, I am sure, I would not have otherwise recognized.”

After graduating from the Junior Fellow Academy last year, Dr. Siddiqi was invited to become an Associate of CIFAR’s *Successful Societies* program.

Her recent collaboration with other CIFAR researchers examines how economic institutions and social policies can have an impact on population health. This work will be published in the April 2012 issue of the prestigious *Annual Review of Public Health*.

Dr. Siddiqi is now an assistant professor at the Dalla Lana School of Public Health at the University of Toronto.



KRISTER SHALM

Inspired by the magic of the quantum world

When Krister Shalm first heard about quantum computing in university, he became fascinated with understanding how the quantum world could help to solve real-world problems. So fascinated that he neglected to study for his other exams.

Today, Dr. Shalm works with high-powered lasers at the University of Waterloo's Institute for Quantum Computing, exploring how light particles interact with matter. "I love to learn about the world around me," he says. "I sometimes catch myself

marvelling at the fact that we have only scratched the surface of the possibilities that quantum mechanics will open up in the future."

For Dr. Shalm, joining the Junior Fellow Academy in 2010 has been a real inspiration. "The mentorship by my direct adviser and by other program members at CIFAR meetings continuously inspires new research ideas. There is a sense of camaraderie in the Academy – friendships that will last throughout my career as a scientist and beyond."

As he learns more about how nature works, Dr. Shalm has dedicated himself to sharing his work with others. He blogs regularly at Quantumpie.com and also works with a local magician to teach the public the "magic" of the quantum world.

"Some people want to change the world, I want to explain it," he says.



ELSE STARKENBURG

Solving the puzzles of the galaxy

Else Starkenburg was always passionate about science, so studying physics and astrophysics at university was a natural choice. While doing a Master's degree at the University of Groningen in the Netherlands, she realized just how fascinated she was by the Universe – and how little we know about its history.

A "galactic archaeologist," Dr. Starkenburg is one of the newest inductees into the Junior Fellow Academy. Her research aims to understand the history of our astronomical backyard – the Milky Way, and the smaller galaxies surrounding it.

Solving the small puzzles within the bigger picture of the Universe is Dr. Starkenburg's focus. She is excited to contribute to a better understanding of how galaxies came to be.

Being a Junior Fellow is already opening doors for her. "I am very enthusiastic about the opportunity to discuss challenges with scientists at a similar stage in their career," she says. "I am also hoping that participating in this network will broaden my view and lead to interdisciplinary collaborations."

As she dives into a postdoctoral fellowship at the University of Victoria, Dr. Starkenburg is studying individual stars and testing theories about how galaxies form and evolve.

Investing in the future



Why do I support CIFAR? That's easy. I love that CIFAR conducts risky, long-term research that focuses on the root causes of the world's biggest challenges.

Maybe it's because Canadians are, by nature, more collaborative. But somehow, CIFAR brings together people, institutions and countries that wouldn't normally intersect. These diverse groups collaborate to better understand and address some of the globe's most pressing issues.

As far as I am aware, the CIFAR model doesn't exist anywhere else in the world. I believe one of the ways that Canada can contribute in the world is by sharing the CIFAR way of doing things. Frankly, there are not enough of these types of organizations out there.

I also like that CIFAR makes their research accessible to non-experts and explains how big, complex issues relate to our daily lives. I make a point of attending CIFAR events whenever I can. I always learn something new and truly remarkable. For me, this is vitally important.

BILL YOUNG

**Social entrepreneur and
CIFAR donor**

The Canadian Institute for Advanced Research needs the support of people like you to help us keep asking big questions.

CIFAR program members never know where their research will take them. Their questions require explorations of the smallest atoms and the farthest galaxies. The research they do is interdisciplinary, collaborative, risky, and aimed at creating knowledge with the potential to change how we understand our world.

You can join them on their journey by making a tax-deductible donation at:

www.cifar.ca/donate-to-cifar

CIFAR LUNAR CIRCLE

The Lunar Circle comprises an elite group of individuals and organizations with lifetime giving of \$100,000 or more to CIFAR (based on value of gifts received as of December 31, 2011). It was inspired by the 1760s *Lunar Society* — a group of philosophers, business leaders, scientists, and amateur experimenters who met on the nights of the full moon to share and debate ideas over long dinners. Through their collaborations, these individuals together became the catalyst for the industrial revolution.

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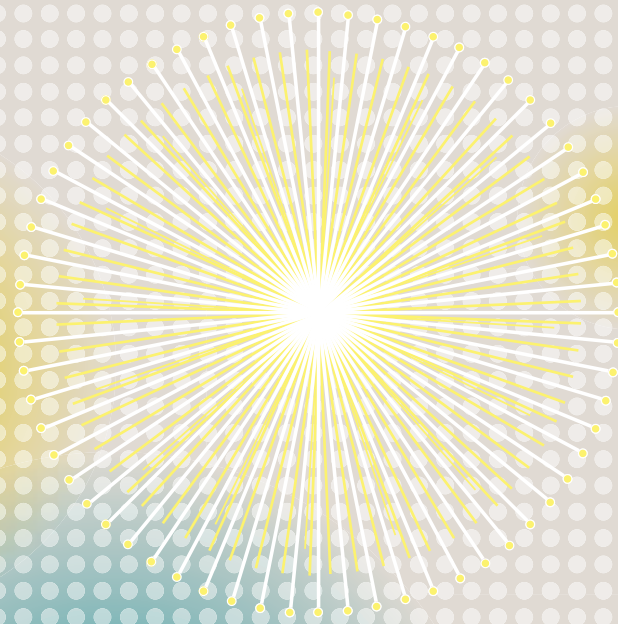
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