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AUSTRALIAN–AMERICAN FULBRIGHT COMMISSION

The Fulbright Program

The Fulbright Program is the flagship foreign exchange scholarship program of the United States of America, aimed at increasing binational collaboration, cultural understanding, and the exchange of ideas.

Born in the aftermath of WWII, the program was established by Senator J. William Fulbright in 1946 with the ethos of turning 'swords into ploughshares', whereby credits from the sale of surplus U.S. war materials were used to fund academic exchanges between host countries and the U.S.

Since its establishment, the Fulbright Program has grown to become the largest educational exchange program in the world, operating in over 160 countries. In its seventy-year history, more than 370,000 students, academics, and professionals have received Fulbright Scholarships to study, teach, or conduct research, and promote bilateral collaboration and cultural empathy.

Since its inception in Australia in 1949, the Fulbright Commission has awarded over 5,000 scholarships, creating a vibrant, dynamic, and interconnected network of Alumni.

"Our future is not in the stars but in our own minds and hearts.

Creative leadership and liberal education, which in fact go together, are the first requirements for a hopeful future for humankind.

Fostering these—leadership, learning, and empathy between cultures—was and remains the purpose of the international scholarship program that I was privileged to sponsor in the U.S. Senate over forty years ago. "

Senator J. William Fulbright
The Price of Empire

Evolution

Why does evolution unfold the way it does? As organisms change over generations, what determines rate and direction of that change? These are some of the major questions that motivate the research of Dr Armin Moczek.

Traditionally, evolutionary biologists define evolution as a change in the genetic composition of a population, and emphasise four mechanisms that can change this composition: mutation and migration can introduce new variations into a population, natural selection favours individuals better adapted to their environment, whereas drift removes individuals at random.

These mechanisms and their roles in shaping evolutionary outcomes are very well established, yet a growing body of work suggests additional, important mechanisms may exist that impact evolutionary dynamics, but have, so far, remained largely overlooked.

For example, it has become clear that parents pass on to their offspring more than just genes. They also pass on antibodies, symbionts, positions within a social hierarchy, or knowledge, thereby creating alternate routes of inheritance.

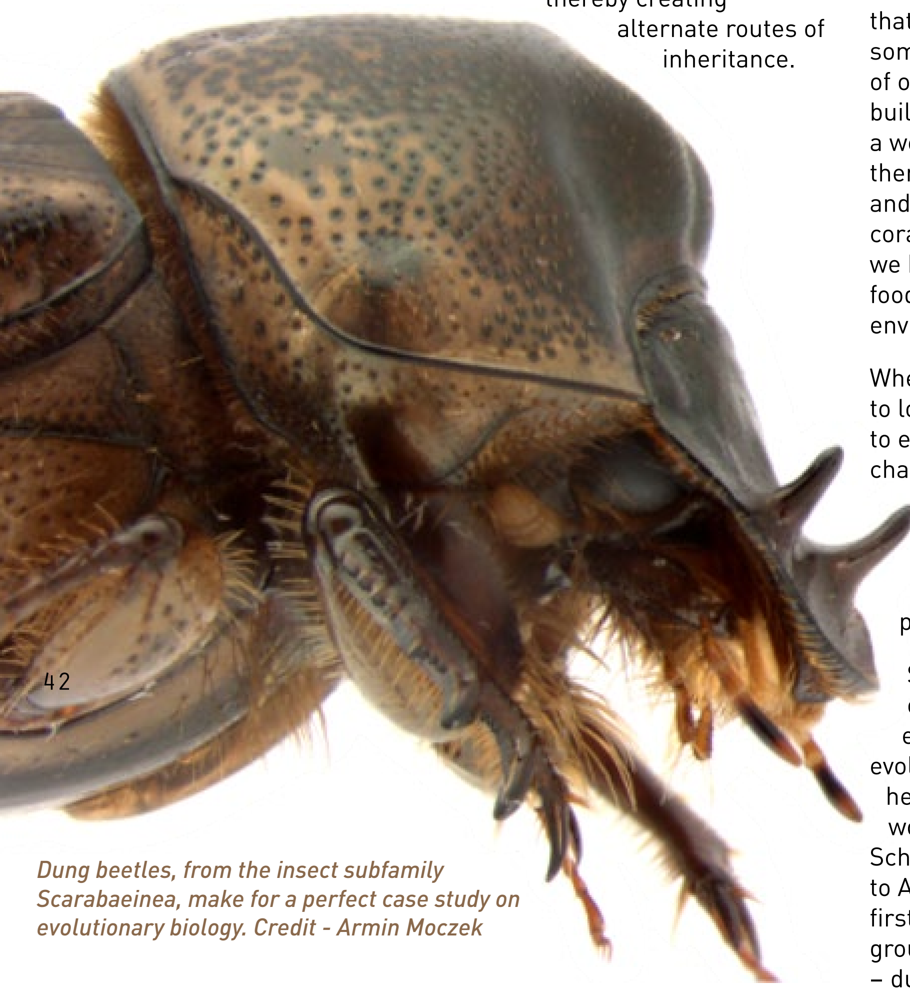
Similarly, evolutionary biologists traditionally view the environment as important because it determines which individuals survive and reproduce well, and which less so.

However, beyond this role, the environment is considered passive and external – when the organism is gone the environment is still there.

A rapidly growing body of work shows that organisms systematically modify their environments in ways that affect their own wellbeing and that of their offspring, and sometimes even entire suites of other species: beavers build dams that help create a wetland environment for themselves, their offspring, and numerous other species; corals build reefs, and we build cities, farm our food, and create a digital environment.

Wherever scientists start to look, organisms appear to evolve not merely by changing their traits to suit their environment, but also to change their environments to suit the traits they already possess.

Studying the significance of these and other extensions to conventional evolutionary thinking is at the heart of Armin Moczek's work as a Fulbright Scholar. It has brought him to Australia to study what, at first, may seem like a peculiar group of organisms – dung beetles!



Dung beetles, from the insect subfamily Scarabaeinea, make for a perfect case study on evolutionary biology. Credit - Armin Moczek

There are several good reasons why dung beetles are actually perfect for this study.

First, research by Armin's group has shown that adult beetles bequeath gut endosymbionts to their offspring. Depending on species, this can be critical for their subsequent growth, survival, and future reproduction.

Similarly, their research demonstrates that both adult and larval dung beetles systematically modify their environment in ways that, again depending on species, can enhance growth, survival, and reproduction.

Most importantly, however, over 40 species of dung beetles have been introduced to Australia by CSIRO in an effort to better control dung breeding flies and enhance pasture quality.

But only about half of these species have managed to get established, and only a handful have done really well. At the same time, among those species which have managed to get well-established were some whose introduced population started to evolve very rapidly, causing them to diverge from the native populations from which they originated to a degree normally only seen between species separated by millions of years.

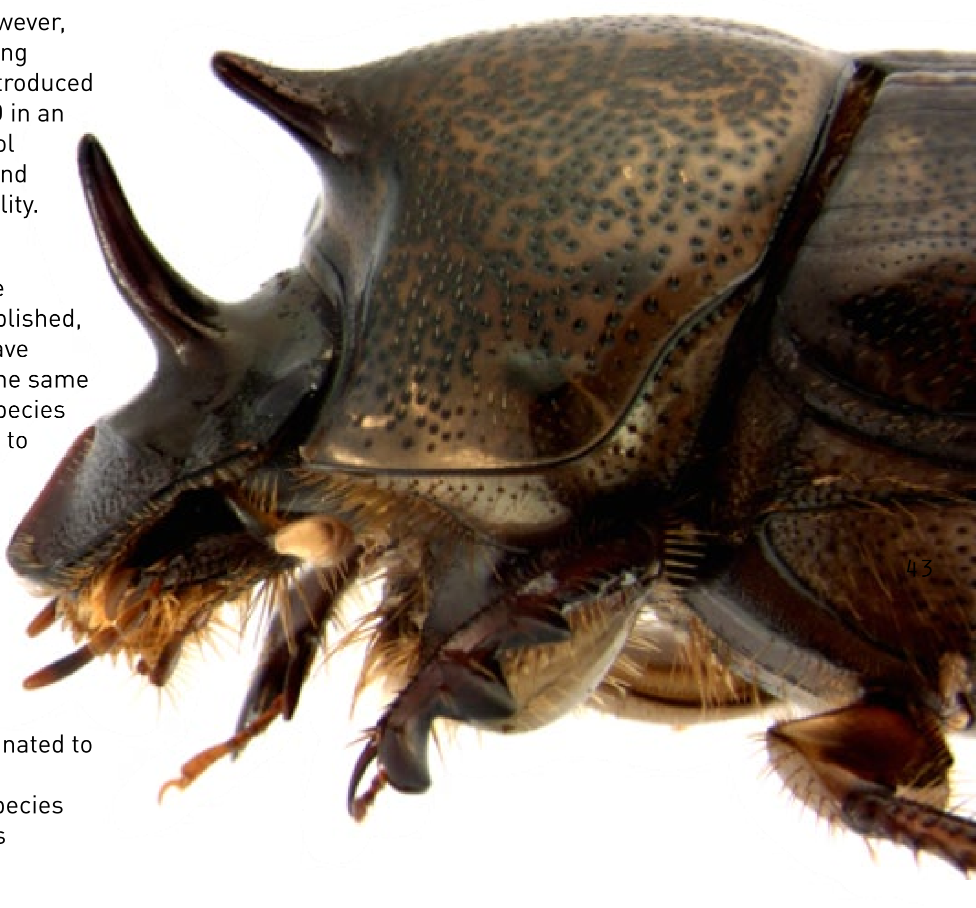
Here, it has only taken *decades.*

To Armin, dung beetles therefore provided a unique test case to assess whether processes like the inheritance of gut symbionts or the ability to modify one's own environment can influence evolutionary outcomes such that it makes the difference between success or failure to colonize and adapt to a new habitat.

To do so, Armin works with scientists at CSIRO Canberra currently involved in introducing additional dung beetle species, and with the Australian National Insect Collection, which holds extensive archival records of introduced and native dung beetle populations.

Armin also executes his own field work, studying and collecting beetles in pastures across the ACT and NSW.

In the process, new collaborations have already emerged, and it is clear that the work begun here will continue to fuel scientific collaboration and exchange beyond Armin's time in Australia.



While in residence, Moczek has presented his work and that of his co-workers at several talks including seminars at CSIRO, the School of Biology at ANU, the University of New South Wales, and the University of Queensland.

Beyond his career as a scientist, Moczek has not one, but at least two parallel lives--one centred on science outreach for public schools and their teachers, the other on increasing minority participation in STEM disciplines.

The Moczek-Lab Science Outreach Initiative is a free program run by Moczek and his team of graduate and postdoctoral students. It aims to help teachers fulfil science education standards across the K-12 sector in Indiana, Moczek's home state in the U.S.

To do so, Armin develops hands-on, enquiry-based science modules that utilize intellectually captivating materials, which he then disseminates to teachers through training workshops as well as direct visits to schools across the state.

So far, Armin's efforts have reached over 400 teachers, and hundreds of classes each year utilize at least one of his modules.

At the same time Armin directs not one but three summer programs aimed at increasing participation of underrepresented minorities in STEM disciplines.

The programs are organized like a pipeline: high performing minority students are identified in early high school through the first program, then return in subsequent years to both deepen and broaden their STEM experiences in the second and especially third program, which then also prepares them for the transition to college and University.

The programs have been highly successful.

"We, at this point, have a 100% success rate at converting program participants into college students, 70% of which go on to pursue STEM majors and STEM-related careers." Says Armin.

"There's really no limit to where they could go in the sciences if they so choose."

The challenges of underrepresentation of minority groups in STEM is, of course, not limited to Indiana. Australia has a similarly skewed demography when it comes to STEM takeup in tertiary institutions, and this has led Armin to seek opportunities to make use of his outreach expertise during his time in the country.

(From top left) Armin with some of the skulls from his Mystery Skulls study module; the STEM education took place at Questacon in Canberra. Credit - Questacon.

When visiting Parliament House as part of the Fulbright contingent in March, Armin met Rod Kennett, Fulbright alum, and Senior Manager at Questacon – Australia's most recognisable science & technology education institution. Their interactions led to a STEM education workshop at Questacon, which provided an overview of Armin's experiences in STEM training and critical lessons learned in the process. Then, local educators who were lucky enough to secure places at the workshop, took on the role of students themselves and dove into two exemplar science modules developed by Armin, one on the evolutionary morphology of mammal skulls called *Mystery Skulls* and one on mimicry and chemical defenses named *Smart Predators/Smarter Prey*.

Participants enjoyed an engaging and enlightening session, replete with Armin's suite of over 40 authentic mammalian skulls, as well as his contagious enthusiasm for the subject material.

The session was recorded by Questacon to be used as a resource for training new generations of science educators. Armin hopes this will only be the beginning of a longer-term collaboration. He plans on seeking avenues for a future return visit to Australia to develop and refine more STEM outreach programs with Questacon.

Armin received his PhD from Duke University, NC, USA, and is currently a Professor of Biology at Indiana University, Bloomington. He is a fellow of the American Association for the Advancement of Science (AAAS) and the John Simon Guggenheim Memorial Foundation.

His research focuses on the very early stages of innovation in evolution, and the interplay between genetics, development, and ecology in facilitating major innovations and transitions in evolution.

He is also a co-leader of an international effort to expand traditional perspectives on what determines speed and direction in evolution to incorporate recent advances in the fields of evolutionary developmental biology, developmental plasticity, non-genetic inheritance, and niche construction.

During his time in Australia, Armin worked at the Research School of Biology at the Australian National University and CSIRO to further advance such a synthesis through both conceptual collaborative efforts as well as empirical work on Australian insects.