



Darwin



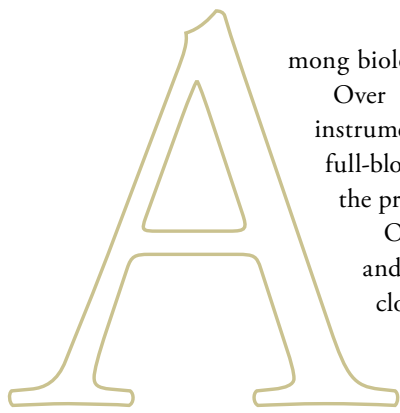
"Whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

— Charles Darwin



DARWIN'S Descendents

BY MICHAL MEYER



THE CONCEPTS
OUTLINED IN
ORIGIN OF SPECIES
150 YEARS AGO
ARE APPLIED
DAILY ACROSS
THE UF CAMPUS

Among biologists, Ernst Mayr is almost as famous as Charles Darwin.

Over the course of 80 years, 20 books and 600 journal articles, Mayr was instrumental in turning an abstract theory about descent by modification into the full-blown science of evolutionary biology, educating generations of scientists in the process.

One of those scientists was Vassiliki Betty Smocovitis, a professor of biology and history of science at the University of Florida who became one of Mayr's closest confidants in the years before his death at 100 in 2005.

"In his later years, Ernst Mayr was a frequent visitor to the University of Florida; he enjoyed visiting with me and other friends, but what he really liked most was sharing his understanding of evolution with a new generation of students," says Smocovitis.

Through those visits and her friendship with Mayr, Smocovitis gained a new understanding of the theory of evolution through the eyes of the man she calls "the Darwin of the 20th century."

"Of all the scientific figures of the 20th century, he came closest to filling Darwin's shoes," says Smocovitis. "By taking Darwin's abstract theory of evolution and turning it into the science of evolutionary biology, Mayr and others helped evolution itself evolve from its early incarnation as an incomplete and abstract theory into a rigorous science

drawing on genetic principles, mathematical tools and some of the most sophisticated experimental methods known to modern science."



DAVID REED FOLLOWS HUMAN'S EMERGENCE AS A DISTINCT SPECIES BY LOOKING AT THE LICE THAT CAME ALONG FOR THE RIDE.

Smocovitis — who has traveled the country over the past year lecturing about Darwin's impact on modern culture as a prestigious Phi Beta Kappa scholar — says the success of the theory of evolution is due to its "synthetic and integrative power."

"It has even become an applied science, embraced enthusiastically by medicine, agriculture, conservation science, even computing and engineering sciences," says the author of *Unifying Biology*, which explores the evolutionary synthesis movement in the scientific community of the 1930s and '40s. "From understanding the evolution of antibiotic-resistant strains of bacteria, to comprehending the reasons for emerging viruses, evolutionary understanding is essential to modern science and its applications."

Indeed, the impact of Darwin's original theory and its scientific progeny is evident across the UF campus.

At the Florida Museum of Natural History, David Reed follows human's emergence as a distinct species by looking at the lice that came along for the ride. Connie Mulligan does the same at the Genetics Institute by tracking genetic markers in human mitochondrial DNA.

At the Emerging Pathogens Institute, David Smith tracks the spread of malaria using cell phone records and airline reservations.



MORE ABOUT DAVID SMITH'S RESEARCH ON PAGE 24

And in the College of Medicine, Martin Cohn studies how fish developed fins to better understand a common birth defect.

MORE ABOUT MARTIN COHN'S RESEARCH ON PAGE 18



These and other UF scientists share a commitment to the revolution Darwin's treatise on evolution sparked.

"Evolution is the fundamental thing that ties all of biology together and makes it a science," says Smith.

Reed echoes the words of Mayr's contemporary, the renowned evolutionary biologist Theodosius Dobzhansky, when he says, "nothing in biology makes sense except in light of evolution."

EVOLUTIONARY HITCHHIKERS

When David Reed talks about his research with lice, people can't help but start scratching.

"People are interested because they're yucky, and they're amused that these nasty parasites have something to offer," says Reed, assistant curator of mammals at the Florida Museum of Natural History. "What's remarkable about these lice is that they record human evolutionary history."

Lice, it turns out, are very particular about their hosts and remain forever bound to their host species. The lice humans carry today have accompanied us throughout our evolutionary history — the closest living relative to the head lice found on school children lives on chimpanzees. These two types of lice went their separate ways about five to seven million years ago, when humans and chimps split from their common ancestor.

**"EVOLUTION
THIS IS MERELY
CONTINGENT ON
CERTAIN PROCESSES
ARTICULATED BY
DARWIN: VARIATION
AND SELECTION."
— ERNST MAYR**



“Lice have been with us the whole way,” says Reed, who recently won a five-year, \$934,498 grant from the National Science Foundation to continue his research. “When we left Africa 100,000 years ago as a small group, they did, too.”

And that makes them ideal for clarifying when and how that trek out of Africa occurred.

Reed says that by comparing the emergence of the two types of human lice — head lice and clothing, or body, lice — scientists can infer a lot about human migration.

“Clothing lice could not have emerged until clothing existed, so we can use the emergence of that louse to estimate when humans started wearing clothing,” he says.

By studying the mutation rates and DNA of modern lice, Reed has been able to estimate that body lice differentiated from head lice about 650,000 years ago — long before Neanderthals and modern humans existed, and much earlier than the previously accepted 100,000 years for the origins of clothing.

This earlier date also correlates with fossil evidence of when hominids first successfully moved into Europe and Asia, a feat that would have been difficult if the people didn’t have animal skins to protect them from the much colder climate then.

Reed has also used lice to gain a greater understanding of when some of our relatives went extinct.

The genetic lineages of lice, it turns out, are much older than the genetic lineages of humans, which puzzled Reed.

“Neanderthal lice genes are still around, homo erectus lice genes are still around,” says Reed. “How could DNA for lice that lived on species of now-extinct hominids still exist?”

His conclusion: “We picked them up from Neanderthals when humans and Neanderthals lived in the same place.”

Anthropologists disagree on whether homo erectus overlapped in time with Neanderthals, but Reed says: “We think the lice hints at an overlap between erectus and sapiens in Asia.”



**EVOLUTIONARY
GENETICIST MARTA
WAYNE IS USING FRUIT
FLIES TO TRY TO FORCE
AN EVOLUTIONARY
CHANGE TO OCCUR IN
HER LAB.**

While Reed focuses on lice, evolutionary geneticist Marta Wayne is using fruit flies to try to force an evolutionary change to occur in her lab.

Because even distantly connected species — like fruit flies and humans — share many of the same genes, scientists like Wayne can use animals as genetic stand-ins for humans.

Wayne’s work focuses on virulence in fruit fly viruses.

“We’re all obsessed with emerging diseases: dengue, Ebola and all the other nasty things,” she says. “Are these diseases ‘emerging’ because they’re becoming more virulent and so we notice them or is it because humans are encountering the native animal hosts more often?”

Working with an RNA virus that infects only fruit flies, Wayne is attempting to force a change in the virus’ virulence. Such an approach will provide answers to the relationships between virus amounts, the corresponding harm to the fruit fly, the fly’s ability to pass on the virus, and the virus’ ability to infect other fruit fly species that do not normally carry the virus.

Theory predicts the virus’s shift to a new species will increase its virulence, says Wayne, but that must be tested using real animals with real immune systems.

Most people don’t worry much about fruit fly viruses, but mosquitoes and fruit flies belong to the same family, and both carry RNA viruses.

“What happens in mosquitoes,” says Wayne, “is very relevant to human health.”



**“FROM UNDERSTANDING THE
EVOLUTION OF ANTIBIOTIC-
RESISTANT STRAINS OF
BACTERIA, TO COMPREHENDING
THE REASONS FOR EMERGING
VIRUSES, EVOLUTIONARY
UNDERSTANDING IS ESSENTIAL
TO MODERN SCIENCE AND ITS
APPLICATIONS.”**

— BETTY SMOCOVITIS



Ray Carson



**CHARLES BAER
SEEKS ANSWERS
TO MORE
FUNDAMENTAL
QUESTIONS ABOUT
POPULATION
DIVERSITY.**

MANAGING MUTATIONS

While Wayne's work is applied evolution with obvious implications for human health, Charles Baer seeks answers to more fundamental questions about population diversity.

"Why do different populations and different species have different amounts of genetic variation," he asks.

That's an important question because genetic variation or mutation is the mechanism by which living things adapt to changes in their environment — like global warming.

Generally, mutations are bad for the individual. We all know someone suffering from genetic diseases like cystic fibrosis or sickle cell anemia. But some mutations can be good, like in the famous example of the moths that mutated to become darker so they would blend in better with the soot-stained walls of industrial England.

To better understand the underpinnings of mutation, Baer turned to several species of nematodes, or roundworms, that were very similar except for one big difference — some reproduce asexually and some sexually.

"Sexual reproduction seems awfully complicated," Baer says, especially compared to asexual reproduction, which requires only one individual.

But, an asexually reproducing worm will pass along ALL of its genes — good and bad — to ALL of its offspring, unlike a sexually reproducing worm, where only half the genetic complement of each parent ends up in its offspring.

"It turns out," Baer says, "that bad mutations are more easily gotten rid of in sexual reproduction."

And it turns out that natural selection in real life follows evolutionary theory. Baer's research indicates that self-fertilizers have lower mutation rates than their sexually reproducing cousins.

Darwin — who received no formal training in biology — couldn't have envisioned the methodology of modern biology, says Smocovitis, but *Origin of Species* does anticipate some of the ideas that have emerged in the last half century.

"Darwin, of course, didn't understand the principles of heredity — that was his contemporary Gregor Mendel's domain — but he knew that it was critical to understanding the origin and maintenance of variation," Smocovitis says. "He also knew that the Earth was much older than his contemporaries postulated, but that date didn't alter sufficiently until the end of the 19th century when radioactivity was factored into calculations for the age of the Earth."

Although modern biological techniques might seem complicated, the idea of natural selection is so basic that 5-year-olds can understand it.

When Cohn speaks to kindergarteners about science, he often uses the example of green and brown lizards to illustrate the concept of natural selection.

"If birds like to eat lizards in spring, when the grass is green, which lizard do you think the bird is going to eat," he asks. Cohn then reverses the argument for a fall garden filled with brown leaves.

"They can see how population dynamics change due to natural selection, and they can understand how that would lead to extinction events," he says.

For Reed, evolution suggests better ways of living.

"We are part of a really big system and just because we have the ability to alter the environment and ecosystem doesn't mean we should. A basic understanding of evolution grounds you in how to be a better citizen of this planet."

Perhaps it's fitting that Darwin has the final word on the subject. On the last page of *Origin of Species* he muses: "Whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved." ❌

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IN DARWIN'S FOOTSTEPS: COLLECTIONS AT UF'S FLORIDA MUSEUM OF NATURAL HISTORY



Jeff Gage

DAVID STEADMAN, curator of ornithology, recently discovered a new genera of the frogmouth bird on a collecting expedition in the Solomon Islands. It was the first frogmouth from these islands to be caught by scientists in more than 100 years. Today, the only museum specimen of this bird in the world, with an associated skin and skeleton, is housed at the Florida Museum.



Eric Zamora

PAMELA SOLTIS, curator of molecular systematics and evolutionary genetics, is a national leader in the development of the flower Tree of Life. Using modern molecular genetics techniques, Soltis and her colleagues have shed light on what Darwin called the "abominable mystery" of early plant evolution. They showed that a stunning diversification of flowering plants, a flower "Big Bang," took place in the comparatively short period of less than 5 million years — and resulted in all five major lineages of flowering plants that exist today.

LARRY PAGE, curator of the museum's ichthyology collection, is currently cataloging catfish species worldwide. Page and his colleagues expect to describe about 1,750 new species to add to the 2,734 recognized species, or one of every four species of freshwater fish. Most of the work is taking place in South America, Africa and Southern Asia, where the largest numbers of catfish species are located.



Jeff Gage

CHARLES DARWIN spent five years circling the globe on the H.M.S. Beagle collecting specimens and recording his observations. Following in Darwin's footsteps, curators at UF's Florida Museum of Natural History catalogue the world's flora and fauna for future generations. The museum is home to one of the world's largest butterfly and moth collections, the world's fifth largest collection of modern bird skeletons, 2 million fish specimens and the country's most significant research collection of the endangered Florida Panther.