Integrative Biology

Spring 2008

Photo: Anand Varma

Photo: John Wieczorek

Photo: Anand Varma / Chris Clark

Letter from the Faculty: Wayne Sousa

Photo: Betsy Mitchell

IB professor Wayne Sousa

Welcome to the maiden voyage of the Integrative Biology (IB) newsletter. We are launching this endeavor as one means of introducing ourselves to new friends of the department, and reconnecting with old ones, especially alumni of IB and of the former departments of Zoology, Botany, Paleontology, Anatomy and Physiology, Genetics, and Human Biodynamics, which merged to form IB in 1989.

IB was conceived as an interactive collection of scientists working at the interfaces of traditional biological disciplines. Rather than focusing largely on phenomena operating at a single level of biological organization (e.g. cells, tissues, organs, organisms, or populations), our research addresses questions that require observational, experimental and/or computational studies of patterns and processes at multiple levels of biological organization, and over a range of spatial and temporal scales. Our studies draw on techniques and concepts that have developed out of a diverse array of disciplines in the biological, physical, and social sciences, as well as engineering. In our view, many of the most exciting and important scientific discoveries emerge from research conducted at these interfaces. While most biology departments on the UC Berkeley campus include some faculty members whose work shares this multilevel, interdisciplinary approach, IB is the only one that is essentially defined by this perspective, and it is a key theme emphasized throughout our undergraduate curriculum. The faculty and student research projects described on the following pages exemplify the broad, integrative vision we embrace.

For additional information about IB, I invite you to explore our departmental web site (http://ib.berkeley.edu/). Our ability to maintain our innovative programs in education and research depends on continuing support from the State of California, the federal government, private companies and foundations, and individual donors. As you have undoubtedly heard in recent news reports, we are facing a particularly serious fiscal challenge, as the state budget deficit skyrockets and public funding for higher education is threatened with deep cuts. Please consider a targeted donation to the Department of Integrative Biology to help our program continue to achieve its rich potential.

My sincere thanks to Jennifer Skene, Emma Brown, Yonatan Munk, and Steve Owen for their creative contributions and hard work in producing this first edition of the IB newsletter.

Undergraduate Profile: Anand Varma

Picturing a career in biology

Photo: Jean Krejca

In August 2006, IB senior Anand Varma strapped on a harness and explored underground caves in Sequoia National Park for the article "New Troglobites," featured in the September 2007 issue of National Geographic.

When Integrative Biology senior Anand Varma recounts his experience working for professor Wayne Sousa as a research assistant in Panama, his eyes light up. The field site was humid, bug-infested, and smelled rather like rotten eggs—"not the most comfortable working conditions," he says, flashing a smile, "but it was great anyway."

That ability to smile under less-than-ideal circumstances, coupled with an unbounded curiosity about the natural world, make 21-year-old Atlanta native Varma an ideal candidate for the usual biologist's career progression: grad school, post-doc, and professorship. That's exactly where he thought he was headed when he came to Berkeley, and with dreams of becoming a marine biologist, he dove into research, first in marine biologist Roy Caldwell's lab, and then in Sousa's.

But last year, Varma stumbled on a different way to make a career out of exploring the living world. At the urging of a GSI who noticed his penchant for photographing birds and flowers during ecology field trips, Varma landed a job as an assistant to National Geographic photographer David Liittschwager, known for his studio portraits of endangered species.

Varma says he acted more as a sherpa than a biologist on his first trip with Liittschwager, to photograph 28 new species of millipedes, spiders and other invertebrates discovered living deep in caves in Sequoia National Park. But on subsequent trips—to archaeological digs in Spain, chaparral-like slopes in South Africa, a marine research vessel in Hawaii, the cloud forests of Costa Rica and a relatively undisturbed corner of Manhattan's Central Park, he's been able to combine biology with the pursuit of beautiful images.

Just as important, Varma says, working with Littschwager has been an opportunity to re-imagine a future that includes the non-stop learning he always associated with science—plus the freedom to travel and discover that photography allows.

"This is giving me the interactions with biology that I want," he says. "It's natural history that is most interesting to me."

So for now, no grad school applications are in the works, and Varma is moving toward his own photography enterprise. Last summer, he documented field work being done in conjunction with the Museum of Vertebrate Zoology's Grinnell Resurvey Project. And now he's charged with photographing the Museum's collection of 14,000 egg specimens—a job that promises to keep him tethered to Berkeley for a while.

"I've got sort of a handle on it," he laughs. "I'm up to about 20."

Varma says the scientists he's met outside academia, on photo expeditions, have inspired him to think more broadly about life's possibilities. "Photography is a way to explore nature that gives me a really broad experience," he says. "I'm going to find that one job where I get to live on that island, go scuba diving everyday and someone will pay me."

—Emma Brown

Stress and the single tuco

Photo: Dick Sage

Woodruff takes a break from research at her field site in Argentina's Neuquen Province.

Who is more stressed out: single moms, or moms who live with other moms? Graduate student Julie Woodruff is trying to answer this question. Not for human moms, but for mama tuco-tucos, gopher-like rodents that live in underground burrows in southwest Argentina.

Tuco-tucos get their name from the noise they make—a sort of "tuk tuk" sound. Their scientific name, *Ctenomys sociabilis*, is equally apt—these are very social creatures. Females often live in groups, sharing a burrow and raising their pups together. But sometimes, female tuco-tucos find their own individual burrows and live alone.

Woodruff's advisor, IB professor Eileen Lacey, compared the survival and fitness of group living and lone females. She found that females in groups tend to live longer than lone females, but they have fewer pups.

To determine what role stress may play in those differences, Woodruff is comparing the stress levels of lone females and females in groups by measuring the amount of the hormone corticosterone in fecal samples. First she catches the tuco-tucos as they are leaving their burrows. She puts them in a cloth bag, where "they are pretty good about pooping." After she's collected the fecal material, they are returned to their burrows.

Woodruff, a mother of four grown children, says she started the project thinking that though no mom can completely relax, loners would be particularly susceptible to high stress levels. "Group living females are probably dealing with social stress, because they're all in this communal nest. Lone females are dealing with more of a physical related stress," because they have to dig and maintain their burrows by themselves.

Sure enough, data from the first year show that lone females are indeed more stressed. For the group living females, says Woodruff, "everybody is digging burrows, pups are coming up wherever they want... It's hard to look at them and say they're really stressed out." Woodruff will need another year of hormone data to say for sure, but "it may turn out that … living in groups actually helps mediate stresses."

Woodruff is not a typical grad student. After raising a family, she started college in her late 30s, finished her undergraduate degree at Berkeley, and then continued on as a graduate student. "Grad school is almost ageless in some ways," she says. And it provides her with an opportunity to study the effect of "group living" on stress in her own life. "The stress makes me old, but being around people who are my kids' age makes me young."

—*Jennifer Skene*

Grad Student Profile: Julie Woodruff

The hummingbird's beguiling beep

Photo: Anand Varma

Clark sets out hummingbird feeders in the Kern River Preserve, near Bakersfield, CA.

When a male Anna's hummingbird wants to impress a female, he shakes a tail feather. Sort of. He does a showy rapid dive maneuver, and at the bottom of the dive's arc, he spreads out his tail feathers for a fraction of a second; the outermost tail feathers vibrate and make a brief "beep" noise. This noise is very similar to the sounds that hummingbirds produce vocally, and this similarity has long caused some confusion as to the nature of the noise. But IB grad student Chris Clark figured out exactly how the feathers flutter and produce the presumably beguiling beep.

Clark and IB undergraduate Teresa Feo used high-speed video to capture the dives of an Anna's hummingbird. There is an audible beep when the bird reaches the bottom of each dive. Says Clark, "I plucked his outermost tail feathers and let him go." A few days later, "he came back and he did a bunch more dives for me… and he couldn't make the sound." Clark had established that the feathers were necessary for sound production.

"If it really was the feathers that were making the sound, well we should be able to get the feathers to make the sound in the lab," says Clark. As part of Feo's undergraduate honors thesis, Feo and Clark used several techniques to see if the feathers alone can make noise. Sure enough, they can. They put a tail feather on a stick and swung it through the air—there was a noise. They puffed a jet of air at the feather—there was a noise. And in a wind tunnel, again using high-speed video, they could see that the trailing edge of the feather was vibrating—and making a noise.

When the barbs on the feather vibrate at just the right frequency, they produce a sound. Clark created a physical model to describe this movement—he compares it to the vibration of a reed in a wind instrument.

The sonant tail feather is not unique to the Anna's hummingbird—dozens of other birds make similar sounds, probably using the same mechanism. "One of the things to pop out of the physics of how the feathers are making sounds," says Clark, is that the feathers "don't have to have a specialized shape or a fancy shape to make a sound. All that has to happen is the air traveling over the feather has to be moving fast enough to excite it into vibrating. This suggests that evolution of this sort of sound could be really easy. Birds are already flapping their wings and flying at high speeds on a regular basis."

—*Jennifer Skene*

Grad Student Profile: Chris Clark

Graduate student

Andrea Swei
Habitat impacts on Lyme disease ecology

California

Brody Sandel
Grassland restoration

California

Brian Swartz
Early vertebrate transition from water to land

Europe / Canada

Chris Clark
Hummingbird tail sounds

California

Matt Medeiros
Flightless alpine jumping moths

Hawaii

Jennifer Skene
Climate change and seaweed ecology

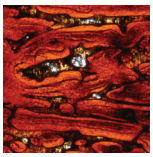
California

Lindsay Waldrop
Juvenile crab olfaction

San Francisco Bay

Sarah Werning
Growth of dinosaur bones

New Mexico



Randy Irmis
Early dinosaurs and their relatives

New Mexico

Greg Goldsmith
Climate change and tropical cloud forests

Mexico / Costa Rica

Yonatan Munk
Aerodynamics of gliding ants

Panama

summer field work

Rebecca Calisi
Neuroendocrinology of cooperatively breeding birds
Kenya

Katie Brakora
Sexual dimorphism in antelope skulls

Africa

Jonathan Fong
Evolutionary relationships of turtles

Africa / China

Yu Zeng
Biomechanics of tadpole surface feeding

Southern China

Greg Byrnes
Gliding behavior of flying squirrels and colugos
Singapore/Malaysia

Shobi Lawalata
Flying lizard biogeography

Indonesia

Matthew Fujita
Evolution in all-female asexual geckos
Australia

Stephanie Bush
Marine ecology and animal behavior

Antarctica

Sam Diaz-Munoz
Male parental care in tamarin monkeys

Panama

Chris DiVittorio
Evolution of plant traits and species diversity
Peru / Chile / Baja

Nathan Kraft
Tropical forest dynamics and plant functional traits
Ecuador

Faculty Profile: David Ackerly

Endemics in danger: Modeling California's floristic future

Photo: Peter Cowan

Ackerly surveys the scene at Jepson Prairie Preserve near Sacramento, CA.

California is home to nearly 2400 species of native plants that live nowhere else in the world. Protecting that endemic diversity is complicated by climate change, which promises to influence the temperature and precipitation patterns that dictate where plants can survive.

With a team of collaborators, Integrative Biology professor David Ackerly, an ecologist who's worked on problems ranging from tropical forest structure to leaf physiology, is working to predict just how the distribution of California's flora will change over the next century.

It's the first such regional assessment of climate change impacts on endemics in North America, and though not yet complete, the results so far are sobering. Up to 30 percent of species could go extinct by the year 2100, according to their model, and another 40 percent could be reduced to ranges smaller than one-fifth their current size.

Beneath that bad news, however, lie important clues for conservationists trying to identify what parts of California will host the greatest diversity in the future, and therefore deserve the most intense protection efforts today.

According to the study, diversity will generally tend to move north and west. The already species-rich Pacific coast region and northern California's Klamath mountains will continue to be important refugia, and the mountains that cup the southern end of the Central Valley also will host an increasing number of threatened species.

The foothills of the northern Sierra, on the other hand, will likely lose species as that area becomes hotter and drier.

The researchers started with plant distribution data compiled in the Jepson Manual, a comprehensive field guide to California plants. That basic information about where plants live now is the best evidence on which to base predictions about where they might live in the future.

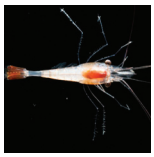
"These are all computer simulations, and we don't have many ways to directly test the predictions," says Ackerly, who will continue using models to explore how California's landscape might look in the future. He says he has trouble digesting the ecological changes predicted by the study, even though he knows the extinction estimates, which ignore the effects of soil specialization and invasive plants, are likely conservative.

Ackerly's work usually has him out in the field, observing today's plants rather than modeling future ones. This work was done on the side, without major funding. It's a question, however, that's too important to ignore, money and research proclivities be darned.

"It's a bit of a jump for me," he says. "But it's harder and harder to be in this field and not be thinking about the effects of climate change."

— Emma Brown

Graduate Student News



Stephanie Bush studies squid inking behavior; the ink is barely dry on her *Marine Biology* publication. Stephanie currently teaches Deep Sea Biology at Cal State's Life Long Learning Institute, and will be doing field work in Antarctica this summer.

To monitor the gliding behavior of colugos, arboreal mammals in Southeast Asia, **Greg Byrnes** straps movement sensor "backpacks" to colugos in the wild. His work was recently published in *Proceedings of the Royal Society B*.

Rebecca Calisi's work on stress and hormones in birds won Best Poster Presentation at the Society of Integrative and Comparative Biology. This summer, Rebecca will go to Kenya to study the neuroendocrinology of cooperatively breeding birds.

What happens inside of a spider egg? **Crystal Chaw's** findings on spider embryo development were recently published in *Developmental Dynamics*. Currently, Crystal is organizing a conference on Evolution and Development at Berkeley.

Tamarin monkeys often give birth to fraternal twin babies, each with a different father— **Samuel Diaz Munoz** studies how males care for babies, which may or may not be their own. He recently presented his work to local residents, zoo staff, and government officials at his field site in Panama.

Jonathan Fong's work on conservation genetics in turtles was published in *Animal Conservation and Conservation Genetics*. Jonathan is currently a NSF GK-12 Fellow at Adams Middle School in Richmond, CA. The program teaches local students about California biodiversity, and teaches graduate students how to be better science communicators.

Where did dinosaurs come from and how did they diversify? **Randy Irmis's** research answers this question; it was recently the cover article in *Science*. This summer, Randy will continue this work and lead a paleontology course for the public in New Mexico.

Matthew Johnson studies exercise physiology. His work on fatty acid breakdown after exercise was published in the *Journal of Physiology*. This summer, Matthew will expand his work to look at brain metabolism in ICU patients, and he will continue to give guest lectures about exercise, nutrition, and performance enhancing drugs for local sports teams and high schools.

Remember Berkeley's foggy summer mornings? **Emily Limm** recently received a grant from the Save-the-Redwoods League to study the how fog slakes the thirst of redwood understory plants in Sonoma County.

Nick Matzke moderated a panel at the 2008 American Association for Arts and Sciences meeting on evolution and public understanding. Nick was also a key witness in the Dover Trial, and was featured in the NOVA program Judgment Day: Intelligent Design on Trial.

Nicolette McGuire studies how hormones affect reproductive timing in birds. Her work was recently published in *General and Comparative Endocrinology* as the cover article. Nicolette also studies whether poor nutrition affects bird testosterone synthesis.

Joey Pakes studies the feeding ecology and evolution of remipedes, blind aquatic invertebrates that live in caves with low oxygen and high sulfide levels. She will spend the summer diving for these extreme crustaceans in Mexico.

Shai Revzen's work on mechanical control in cockroach locomotion was featured in a book-chapter in *"Progress in Motor Control - A Multidisciplinary Perspective"*. This summer, Shai will apply his research to robots running on challenging terrain.

Brian Swartz was granted permission to dissect the coelacanth (the oldest lineage of jawed fish) at the California Academy of Sciences. He will be one of only 12 people to have done so!

Sarah Werning discovered that dinosaurs reached sexual maturity before they were fully grown. Her paper, written with recent IB grad Andrew Lee, was the cover article of *Proceedings of the National Academy of Sciences*. Sarah continues her field work on Late Triassic dinosaur, amphibian, and crocodile-like fossils in New Mexico.

Jann Vendetti received a National Science Foundation East Asia and Pacific Summer Institute Fellowship to study the larval evolution and biogeography of whelks in Japan this summer.

Congratulations to **Chris DiVittorio**, **Greg Goldsmith**, **Nicolette McGuire**, **Jay McEntee**, **Naomi Ondrasek**, **Joey Pakes**, and **Sonal Singhal** for receiving a three-year fellowship from the National Science Foundation, and to **Molly Wright** for receiving an honorable mention.

My Summer Vacation:
Flying home for flying lizards

This summer I'm going home to Indonesia to study flying lizards. I'll be working in an archipelago in the westernmost part of the country, called the Mentawai Islands. It's a popular surfing spot for those wave riders, but in terms of historical biogeography little is known about the non-primate biota of these islands. The primates enjoy a little bit more publicity because the islands harbor about 4 endemic monkey species, and let's admit it, people care more about furry things than crawling things. I will be collecting flying lizards from the genus Draco. There are about 11 species distributed in the area, but only about 5 are found on the islands. I am going to use them as a model system to answer questions on how the faunal assemblage of the region took place.

— *Shobi Lawalata*

Photo: Matthew Fujita

We'd love to hear from you! If you'd like to share feedback or tell us what you're up to — or if you know someone who would like to receive this newsletter — please send an email to **newsletter@berkeley.edu** and include your degree and graduation year.

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	Emma Brown
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	Sonal Singhal

Images from the back cover (L-R):
Colugo gliding while carrying young *(Norman Lim)*
Ostrich egg from the Museum of Vertebrate Zoology collection *(Anand Varma)*
Tamarin, Soberanía National Park, Central Panama. *(Anand Varma)*

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