THE UNIVERSITY OF MICHIGAN
DEPARTMENT OF ECOLOGY AND EVOLUTIONARY BIOLOGY

NATURAL SELECTIONS

VOL.5 NUMBER 2 SPRING 2008

Web window to biodiversity

If you've heard the buzz about the Biodiversity Portal and wondered what it was all about, now you can find out at http://www.ummz.lsa.umich.edu/biodiversity.

"This Web page provides a doorway for students or interested members of the general community to conveniently link to all the U-M resources that relate to the study of biodiversity," said Bill Fink, EEB professor and director of the Museum of Zoology.

"It's a wonderful way for a visitor to find out about past or current work on topics ranging from basic ecology to conservation biology and climate change," added Phil Myers, EEB professor and curator of the Museum of Zoology. "It also provides an excellent means of finding out about the people who do this work."

Altogether there are currently 21 units participating in the portal including many U-M departments, programs, facilities, museums and several state organizations working in related areas.

"We've scoured the campus to find programs and faculty involved in research on all aspects of biodiversity," said Myers.

see Biodiversity, page 7

Chimp genome could reveal causes of human disease

Did you read the headlines last year that chimps are more evolved than humans? Maybe you heard jokes about it on Comedy Central's *The Colbert Report* or on NPR's *Wait, Wait, Don't Tell Me*.

If you did, then you are already somewhat familiar with the research of Meg Bakewell, a graduate student in ecology and evolutionary biology who, along with her advisor, Professor George Zhang and postdoctoral fellow Peng Shi, were the brains behind the news that captured worldwide attention. As you can imagine, there is much more to the story than the headlines suggest.* Their paper was published in the *Proceedings of the National Academy of Sciences* in April 2007.

The researchers compared the genomes of humans and chimps and found more positive selection in protein-coding genes in chimps than humans during the time frame under study – from one to six million years ago. When comparing the properties of the positively selected genes, a counterintuitive finding emerged. In humans, the positively selected genes are more often associated with disease. This is the current focus of Bakewell's research.

Meg Bakewell

Not all changes that happen over the course of evolution are beneficial. Most are neutral, but as the environment changes or the genetic background changes, those changes can end up being harmful in the new context.

Bakewell is paying close attention to some studies underway that are investigating the causes of disease, such as the tendency of proteins to aggregate and clump together. This is what happens in Alzheimer's and other neurodegenerative diseases like Parkinson's.

"I'm looking to see if mutations in the human and chimp lineages are different

see Chimp genome, page 3

"Stowaways" helped first land plants survive

About 480 million years ago plants began their journey from sea to land, some 118 million years before animals began to appear on the scene.

While it's hard to comprehend time spans as long as these, today's scientists are able to study the living relatives of these early plants to discover more about plant evolution in prehistoric days. Graduate student Bin Wang is studying the earliest known lineages of living land plants – bryophytes (mainly liverworts) – and the beneficial fungi hidden inside the absorptive tissues of these plants. He is exploring the origin and evolution of this broadly distributed symbiotic association, called mycorrhizae.

Mycorrhizal fungi increase a plant's ability to take up water and mineral nutrients by enlarging the absorptive surface of the plant's roots. More than 90 percent of today's plants have associations with mycorrhizal fungi.

Special genes in the plants control the proper development of mycorrhizae. These mycorrhizae-controlling genes were recently found in some legume

see First land plants, page 4

chair's notes

Deborah E. Goldberg
Elzada U. Clover Collegiate Professor and Chair, Ecology and Evolutionary Biology

Dear Friends,

This issue of the EEB newsletter focuses on our wonderful graduate students. Some of you were graduate students here yourselves, but many of you probably remember graduate students primarily as your graduate student instructors (GSI) in laboratory or discussion sections. We are enormously proud of our GSIs and their dedication and creativity in teaching and are pleased that they often receive recognition for their work. Since the beginning of EEB in 2001, our graduate students have received five GSI Awards from the Rackham Graduate School. Given that only 20 are awarded annually and there are over 2,000 GSIs at U-M eligible to receive these awards each year, it is clear that our graduate students go well beyond the norm in their contribution to undergraduate education.

Increasingly, undergraduates in EEB and the Program in Biology work with graduate students in research, both on independent projects or as research assistants. We have encouraged more partnering between undergraduate and graduate students within laboratory groups to expand research opportunities for undergrads and expose them to the energy and enthusiasm of our graduate students. Faculty research mentors are also always involved so that they help train the next generation of faculty in how to be successful mentors of student research. This has been a very successful program and we continue to seek funding to expand the number of graduate student research mentors and to increase funding available for undergraduate researchers to purchase supplies and equipment or travel to field sites and conferences to present their work.

We strongly support and encourage our graduate students in their teaching and mentoring activities, but also need to provide them with time and resources to focus on their own development as independent researchers. The graduate students in EEB are the next generation of educators, researchers and communicators in universities and colleges, government agencies and non-governmental organizations. The research skills they learn here not only contribute to their own success but to the knowledge needed to solve the many societal problems that require deeper understanding in ecology and evolution.

But developing those skills requires the time to devote to research and the equipment, supplies, assistants, and travel to make that research successful. Our alumni have been marvelous supporters of this effort in the past. In fact, we have a number of endowments to support graduate student research including fellowships named for Helen Olson Brower, Emma J. Cole, Peter Olaus Okkelberg, Angeline Whittier as well as the E.S. George Reserve Scholarships. However, research costs continue to rise and in order to compete with other universities for the very best students, we must continue to raise their stipends. With the new 2-for-1 match for graduate support from the President's Challenge Fund (see page 7), your donations to EEB are increased by 50 percent, making this the perfect time to help us support our students.

In this issue we highlight just a few of our outstanding graduate students – I only wish we could tell you about more of them and the exciting research they do (although the most recent issue of *LSAmagazine* features several more of our great students). Many students have their own Web pages and you can find out more about their dissertation research (and other interests) at http://www.eeb.lsa.umich.edu/eeb/people/grads.html.

With many thanks for your ongoing support of EEB and my best wishes for the summer. As always, we welcome your news and your visits.

Warm regards,

Deborah E. Goldberg

graduate feature

Rustic coffee farms keep ecosystem buzzing

Chiapas, Mexico is home to a mosaic of highland coffee farms, native forest patches and mountains. Within this lush, tropical setting brightly colored birds entertain and background music is provided by buzzing bees.

Shalene Jha, a doctoral student in ecology and evolutionary biology, makes annual excursions to a coffee growing region in Chiapas to examine bee communities and native tree populations in the coffee farms and surrounding forest patches. The neotropical tree under her microscope is *Miconia affinis*, a predominantly understory tree which grows from southern Mexico to Brazil.

In the course of her research, Jha discovered that *M. affinis* can't self-pollinate, they require other trees and reproduce via a specialized process called buzz pollination. While most plants store pollen on the outer surface of the anthers, buzz-pollinated plants store pollen in bag-like anthers. Only bees that vibrate their underbelly just right can remove the pollen. Jha examines tree pollination and fruit production as an indicator of the tree's health.

Jha's research compares two types of coffee farms to see if pollination success and pollen movement differs. Because rustic (or high shade) coffee farms flower continuously, they may be a high quality habitat for the pollinators of *M. affinis*.

"We've found strong positive correlations between bee community diversity and overstory tree and vegetation diversity," Jha said. In contrast, industrialized farms (low shade) generally don't have overstory trees and if they do, there are few species. These highly managed farms are characterized by more intense sun and the use of pesticides and fertilizers. The more highly managed the farms, the less bee diversity.

"I'm researching whether coffee agroecosystems provide a habitat for native pollen dispersers and seed dispersers of native trees," explained Jha. "By maintaining a diverse agroecosystem, we are also helping to maintain the natural ecological processes which are necessary for native trees."

The more shaded the farms are between the patches of native forest, the easier it is for bees, birds, bats and their pollen and seed cargo, to travel through neighboring farms. Tree cover allows creatures to avoid predators and find food along the way. Using genetics to fingerprint trees and their seeds, Jha is examining just how far the bees travel in different kinds of farms. Well-traveled bees that bring pollen from more distant relatives benefit all organisms, including native crops such as coffee.

Shalene Jha

"Plants and insects come together in a beautiful mutualistic interaction. Without it we wouldn't have many of the fruits and grains we consume everyday," said Jha. "It's important to understand agroecosystems. They feed us and so much of the world is covered by them."

When all is said and done, the buzzing of native bees is the sound Jha likes best.

Chimp genome from page 1

with respect to their tendency to cause these kinds of aggregations. Alzheimer's disease does not occur in chimps or other non-human primates. So, what's going on over evolutionary time to lead to this disease in humans?" Ultimately, it is possible that someone in biomedical research could take her findings to help develop cures or treatments.

"What attracted me to working in primates was being interested and curious about human evolution – how did we get here? What the human-chimp comparison brought home to me is that there is a lot we don't know about other primates that are so closely related to us."

"My field site is the Internet"

"All the differences between us are seen through our human perspective, but we don't think about what's gone on in chimps that has adapted them to their environment," Bakewell said.

*** To find out more, you can Google "chimps more evolved than humans"**

graduate feature

Cornering influenza as it evolves and evades

Sarah Cobey gets excited about infectious diseases, especially rapidly evolving ones that cause epidemics. Don't get the wrong idea. This doctoral student of ecology and evolutionary biology doesn't take pleasure in the illness of others. Well, maybe a little pleasure, but only insofar as their illness provides insights into disease dynamics that may help develop more effective vaccinations.

Sarah Cobey

While browsing a citation database using one of her favorite keywords, "influenza," Cobey happened across a paper in a Russian scientific journal summarizing broad trends in the prevalence of influenza among hospitalized patients in St. Petersburg from 1968-2000.

"The flu time series from Russia are the only data set I know of this kind," said EEB Professor Mercedes Pascual, Cobey's advisor. "They provide a unique opportunity to address cross-immunity between subtypes, an important open question in flu."

Cross-immunity means that having one type (like type B) or subtype of flu (such as H1N1) provides immunity or at least some protection from other types or subtypes of flu.

The data focuses on Influenza B, which has circulated in humans for centuries; H3N2, which appeared in 1968; and H1N1, which reappeared in humans in 1977 after a 20-year absence. Cobey is trying to understand whether there is competition between the types or subtypes of influenza, and if there is, how it affects the dynamics of flu as well as how immunity to these types builds in different age groups. Cobey translated the text from Russian and arranged to collaborate with Dr. Lyudmila Karpova, first author of the study and her colleague Dr. Ivan Marinich.

Cobey is using statistical methods developed by EEB Professor Aaron King, Carlos Breto, a former graduate student in statistics and Ed Ionides, professor of statistics at U-M. Cobey, King and Pascual are working on an ecological model to help her decipher the data.

"It's really exciting," said Cobey. "If we find evidence of competition, there's a better chance of being able to predict what type or subtype will be dominant in the next season."

New vaccines have to be developed each year for influenza because it is a rapidly evolving pathogen, which enables it to foil immunity. There are already models for infectious diseases that don't evolve, such as measles. But there aren't many models for fast evolving pathogens that compete with one another – yet. This type of model could help take much of the current guesswork out of developing vaccines. And that would get Cobey really excited.

Decoding influenza: What do the letters and numbers mean?

H and N are the two surface proteins on influenza viruses.

H is hemagglutinin; it binds the virus to the cell that's being infected. Antibodies that bind to H are especially effective at neutralizing the virus, so the virus can't infect the host cells. This puts H under intense selection pressure to escape detection by antibodies. Most research is dedicated to understanding the evolution of H and how to combine it with ecological models.

N is neuraminidase, a protein that enables the virus to spread to other cells, and which also occurs in multiple forms.

The numbers following H stand for the 16 known forms of H in the order in which they were discovered. The numbers following N correspond to the order in which they were discovered; nine are known.

H1N1

H3N2

First land plants from page 1

plants that appeared later on the evolutionary tree (referred to as "higher plants"). One of Wang's questions is whether these genes are also present in lower plants like bryophytes. If present, do the genes have similar functions in the two types of plant? How did these genes originate and how did they evolve in land plants?

Wang and his colleagues have found that the mycorrhizae-controlling genes do indeed exist in many bryophytes as well as other major lineages of land plants. At least one of these genes – DMI3 – has probably retained its mycorrhizae-controlling functions from bryophytes to higher plants.

They have also found DMI3 fragments in some charophytes, a group of algae that lives in fresh water and is closely related to the land plants. Though requiring further study, this interesting finding implies that the origin of DMI3 may predate land plants. Besides DMI3, all major lineages of land plants share some other genes controlling the mycorrhizae. This strongly supports the idea that the successful colonization of land by plants was not done just by plants but with help from a stowaway – their associated symbiotic fungi.

Because mycorrhizal fungi are so essential for most plants, Wang hopes that a better understanding of their genetics will have important applications for agriculture, ecosystem management and ecosystem restoration. For example, once the genetic basis of mycorrhizal development is known, scientists could make a transgenic (genetically modified) strain of a crop that would be better able to form mycorrhizal associations with fungi.

Bin Wang

Unraveling DNA's mysteries

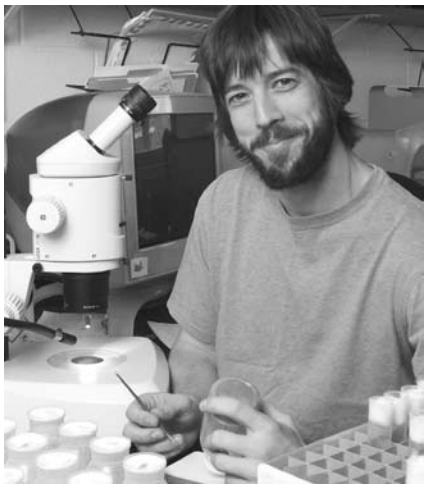
Hundreds of fruit flies lie dormant, knocked out from carbon dioxide, as a researcher painstakingly sorts them with a small artist's brush into groups based on appearance. Something these tiny creatures have in common with humans that makes them ideal for population genetic studies is a similar, albeit much more compact, DNA makeup.

Tim Connallon is a graduate student in ecology and evolutionary biology whose experiments revolve around the evolutionary genetics of the fruit fly *Drosophila melanogaster*. Connallon's research focuses on how X-linked inheritance affects evolutionary processes.

Genetics 101 teaches us that males have an X and a Y chromosome and females have two X chromosomes. Male and female mammals are diploid across most of the genome, meaning they have two paired copies of most chromosomes – autosomes – one from the mother and one from the father. Of our 23 pairs of chromosomes, 22 are autosomes. However, whereas females are diploid for the X, males have only a single copy of each X-linked gene. This difference has important implications for the rate of evolution.

Because males have only one X chromosome, a mutation (or genetic variant) on the X is fully expressed in males, even if it is recessive. For a recessive mutation on the X to be expressed in a female, she would need two copies of the same mutation (on both Xs) – a rare event, made even less likely depending on how rare the genetic variation is. Likewise, recessive mutations are not expressed on autosomes unless the individual has two copies of the same mutation.

Adaptation requires the presence and expression of beneficial variation. Dominant beneficial mutations provide an immediate benefit to individuals that carry them, but recessive mutations are only beneficial when an individual has two copies. Thus, evolutionary theory predicts that, if beneficial mutations are recessive, the X chromosome will adapt more rapidly than autosomes because rare recessive X-linked variation is immediately "visible" to natural selection (via expression in males), whereas recessive autosome variation will be relatively invisible because it won't be expressed. If beneficial mutations are dominant, there will be no "faster-X" effect.



Tim Connallon

"We know that natural selection is playing a role. We wanted to know if it was playing a larger role on X chromosomes or autosomes," Connallon explained.

He distinguished differences between species ('substitutions') caused by genetic drift (chance events) from those caused by natural selection and found no difference between the X and autosomes in their rate of adaptive evolution. The absence of a faster-X pattern implies that beneficial mutations are primarily dominant.

You might ask, why does this matter? One answer is that, as the environment changes, dominant mutations are expressed right away so the population can respond more quickly to natural selection. In a constantly changing world, the ability to continually adapt could be important for species' survival.

The mysteries entwined in strands of DNA will undoubtedly be investigated for many years to come. Connallon and others like him will continue to unravel the clues piece by piece.

Birds and dinosaurs cavorted

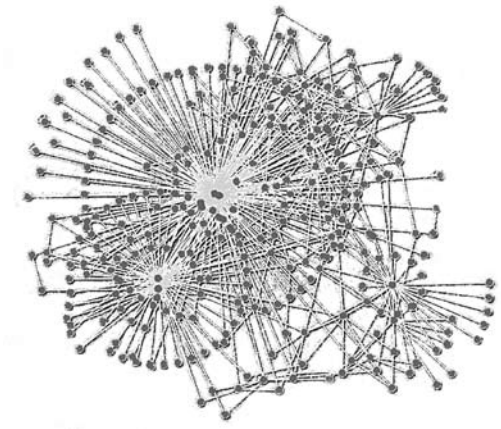
Congratulations to graduate student Joseph Brown who won the $500 Most Outstanding Publication Award for "Strong mitochondrial DNA support for a Cretaceous origin of modern avian lineages." The paper was published online Jan. 28 in the journal *BMC Biology* 6:6.

The Department of Ecology and Evolutionary Biology selects one graduate student paper each year based on study methods, scope of findings, and insights into questions of broad scientific interest using multiple lines of evidence.

His analysis, along with co-author Professor David Mindell and others, offers the strongest molecular evidence yet for a Cretaceous origin of modern birds, suggesting that they arose more than 100 million years ago, not 60 million years ago, as fossils have suggested. The story was widely covered in the media.

The paper can be found at: http://www.biomedcentral.com/1741-7007/6/6/abstract

Networks in Ecology and Evolution



"Wanting connections, we found connections – always, everywhere, and between everything. The world exploded in a whirling network of kinships, where everything pointed to everything else, everything explained everything else…"
Umberto Eco, "Foucault's Pendulum"

The fourth Early Career Scientists Symposium brought together scientists with overlapping research interests on Saturday, March 15, 2008.

"From food webs to molecular networks, interactions took center stage," said Professor Patricia Wittkopp, symposium chair. Speakers' talks ranged from interactions among genes in a single organism to interactions among species living in diverse communities. "As the speakers presented details of their favorite systems, common themes emerged, although the same idea was sometimes given different names. For example, canalization, robustness, stability or buffering all refer to keeping a system running smoothly in the face of change."

The symposium drew the largest and most diverse crowd to date with 150 registrants (up over 50 percent from previous years), 25 percent from other universities and registrants from physics, epidemiology, statistics, life sciences, human genetics, public health and more.

The 10 speakers hailed from five different countries. Dr. Andreas Wagner of the University of Zurich in Switzerland and Dr. Jordi Bascompte of the Biological Station of Doñana, Seville, Spain presented keynote talks.

"Complex networks of interaction are a hallmark of ecological and evolutionary systems," said Chair Deborah E. Goldberg, Elzada U. Clover collegiate professor of ecology and evolutionary biology. "Our hope is that bringing together a diverse group would help take the field in some new directions through cross fertilization. I was thrilled to see the exchanges and debates between people of different disciplines among the speakers and members of the audience."

EEB graduate students shared their work with guests during a lunchtime poster session. Sponsored by the Department of Ecology and Evolutionary Biology, the symposium is funded by the generous donation of Dr. Nancy Williams Walls, a U-M alumnus. Walls attended the event and has graciously made a donation to fund another symposium in 2009.

Aim high!
Frontiers Master's Program

The new Frontiers Master's Program is designed to attract a diverse student body interested in ecology and evolutionary biology research. Students have the chance to explore the full range of research approaches in EEB – from molecular biology in labs to field work in remote areas of the world. The fully-funded program will give students the foundation they need to continue on to top-rated Ph.D. programs.

"One of our goals is to attract students into graduate work in EEB who might not otherwise get the opportunity to study in this area," said Professor Mark Hunter, director of the program. "As a faculty, we believe that a graduate student body with diverse backgrounds provides a stimulating academic environment for everybody."

The four students who will join the program this year will be part of exciting research that has a positive impact. They will explore a wide range of questions in ecology and evolutionary biology and their applications to solving problems in areas such as sustainability, health, and conservation. Incoming students will spend eight weeks this summer at the U-M Biological Station in Pellston, Mich.

Frontiers students will join an internationally diverse student body from over a dozen countries. The program offers the opportunity to work with outstanding researchers and study with faculty committed to ensuring an exciting and supportive environment for all students. Areas of study include comparative biology and systematics, ecology, evolutionary processes, paleobiology and organismal biology.

"I was targeted by a program similar to this one when I was college-age. Oxford University ran a program to enroll students from non-traditional backgrounds, and I was able to take advantage of that," Hunter said. "It changed my life and my career goals, and that's what we're hoping for with the students we recruit to the Frontiers Master's Program."

The Frontiers Master's Program in EEB has received initial funding from the U-M Rackham Graduate School, Michigan AGEP Alliance (Alliances for Graduate Education and the Professoriate) and the College of Literature, Science, and the Arts. Students receive a stipend, tuition and health care for two years. It is anticipated that the program will fund four incoming students each year. EEB is actively looking for a foundation or other support to provide long-term program funding.

Biodiversity from page 1

The portal features articles on ongoing biodiversity research, projects and grants at U-M. The portal will provide an entryway to the entire range of biodiversity research and education on campus and beyond, with emphasis on the state of Michigan and the Great Lakes region. Future plans include a major educational component to the portal for grades K-12 such as teacher guides and a dynamic search engine to provide links throughout the university and beyond.

U-M matches your student donations 2:1

Have you ever wondered just how much it costs to support a graduate student these days? A graduate fellowship costs approximately $50,000 annually and EEB currently has 63 doctoral students – that's $3.15 million a year. While our students spend some of their time as graduate student instructors – essential partners in our mission of educating undergraduate students – it is critical that they also have time to focus on their research, whether it is in the lab or in field sites around the world.

Additional support is needed to fully fund graduate student fellowships and to remain competitive with other universities. Your donations will be used to help support our promising graduate students during their time at the University of Michigan before they venture out into the wider world to educate the next generation of students, further their research, apply their knowledge and seek to make the world a better place.

We are now in the final months of the Michigan Difference Campaign. President Coleman has created a matching gift program to help departments and programs recruit and educate the best graduate students in the nation. Every $2 given to graduate student support before December 31, 2008, will be matched with $1 from the President's Challenge Fund. All gifts from $1 to $1 million will be matched. Details on the U-M program can be found online at www.giving.umich.edu/where/presidents_challenge.htm. For those who prefer to support EEB in a more general manner, money is also needed for department strategic funds. These donations are not eligible for matching funds.

Thank you, in advance, for supporting our graduate students and the Department of Ecology and Evolutionary Biology.

The Michigan Difference
CAMPAIGN FOR MICHIGAN

*Graduate fellowships and research support

*Endowed professorships

*Undergraduate scholarships

*Departmental Seminar Series

*Michigan Early Career Scientists Symposium in Ecology and Evolution

*Biodiversity Research Initiative for Undergraduates

*Department Strategic Fund

Full descriptions of these priorities are available on our Web site **www.eeb.lsa.umich.edu**

The EEB buzz: Your alumni news online

Send us your alumni news for the EEB website: employment changes, recent publications, research grants, awards, degrees or just an interesting story. We'd love your feedback on this newsletter too. Please e-mail eeb-webinfo@umich.edu or mail the form below to:

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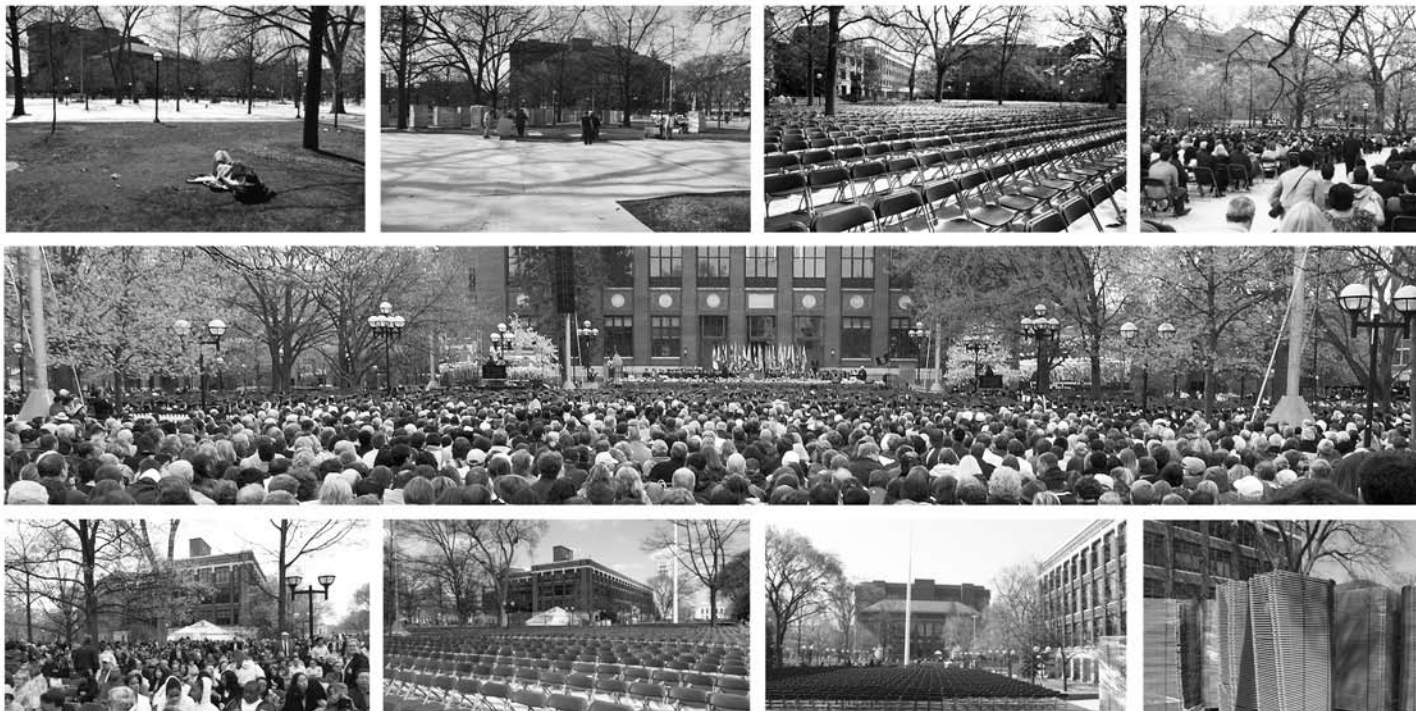

4.26.08: Graduation on the Diag
For the first time in the University of Michigan's 191-year history, Spring Commencement took place on the Diag. 30,000 folding chairs and 20 bleachers were set up among blossoming trees. About 5,000 graduates received their diplomas at this historic event. The Natural Science Building can be seen in the background, where EEB Chair Deborah E. Goldberg and others watched from her skybox office suite party.

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