ANNUAL REPORT
January–December 2013

Monte L. Bean
Life Science Museum
College of Life Sciences
Brigham Young University
The Monte L. Bean Life Science Museum at Brigham Young University is a dynamic repository and trustee for a remarkable group of biological collections. These collections are used to celebrate the role of Jesus Christ as Creator, while enhancing student learning and mentoring and promoting faculty teaching and research. They also serve as a unique venue for inviting the public and scientific community to explore and contemplate intricate biological relationships and processes.

We accomplish our mission by

• Collecting and properly maintaining biological specimens and associated data to effectively support current and future research efforts;
• Providing and developing database options to better support research concerning the biodiversity and ecological complexities of the earth’s ecosystems;
• Producing and sharing quality research products in order to increase scientific knowledge and understanding;
• Facilitating an ongoing dialogue about issues and concerns related to faith and science as different but complementary ways of knowing;
• Educating our students and the public about the natural processes essential to sustaining the biological diversity and ecological health of the earth;
• Providing a forum for educating our students and the public about best earth stewardship practices;
• Promoting and facilitating quality learning and mentoring experiences for our students;
• Engaging the public effectively through compelling exhibits and innovative education programs in order to promote understanding and appreciation for the diversity and complexity of the earth's biological heritage;
• Using the museum's resources to develop and implement K-12 science education programs based on the Utah State Core Curriculum in order to enhance the education of our local public and private school children while providing powerful, “hands-on” training experiences for pre-service primary and secondary teachers in the School of Education.
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A lmost exactly one year after the museum construction and remodel began, Wadman Corporation “handed over the keys” to a beautiful new 30,000 SF addition to the east side of the existing building! The new addition consists of three levels that match the three levels of the existing building. The basement level (10,000 SF) houses the museum’s exhibits team, including the people who plan, design, construct, and install new or updated exhibits. The ground-level space (12,000 SF) has a beautiful center atrium with a much larger museum store, new restrooms, an orientation classroom, two new classrooms, the new President Boyd K. Packer Gallery, and offices for the museum’s education team. The third level (8,000 SF) provides impressive upgraded exhibit spaces. We have also remodeled major portions of the existing building in order to better serve the museum’s patrons and facilitate the work of the museum’s staff. Finally, construction of a new 2300 SF underground Wet Collections Facility was completed in September 2013. This facility will provide state-of-the-art curation and storage space for the museum’s large and valuable ethanol-preserved collections, which include fish, reptiles, amphibians, crustaceans, aquatic insects, and a limited number of mammals. Over the next six months, in preparation for reopening the museum, the museum team will be constructing and installing more than 25 new exhibits while planning for a grand reopening sometime in the late spring of 2014.

D uring the closure period, the museum’s education team continued with an aggressive outreach program in order to keep the museum effectively connected to our public and private school partners. During the closure year, we were able to significantly increase our outreach efforts by expanding the number of off-site live-animal shows and by offering real-time live-animal shows (webcasts) remotely via the internet. We have also developed and offer an impressive variety of online options to our patrons and school partners through the museum’s website (http://mlbean.byu.edu).

W e plan to greet our patrons in the spring of 2014 with an impressive group of new exhibits built around the theme of “Protect Your Planet!” When we reopen, we are confident that our patrons will feel right at home—but with a clear awareness that the museum is not only bigger but much, much better!

T he museum’s curatorial personnel and Lytle research team have continued to be productive and active with the care and use of the museum’s valuable and unique resources. Their productivity is clearly demonstrated by 68 peer-reviewed publications and
the substantial external funds they’ve generated in support of their world-class research and student mentoring. The museum’s research collections have continued to be actively used to teach our students in both undergraduate and graduate classes. The curators have also continued to provide colleagues around the world with access to specimens and information in support of a worldwide effort to better understand the diversity and complexities of life on earth. One of our top priorities with the remodel of the existing building has been not only to provide additional quality space for the collections and curators but also to provide better security and controlled access to the research collections.

The extensive flood-control measures and construction of the new bunkhouse facility at the Lytle Ranch Preserve were completed in the early spring of 2013—all in time for the spring-summer field season! The new bunkhouse provides dorm-style sleeping quarters for 24 people, as well as bathroom facilities, a large eat-in kitchen, a commons area, and a classroom. With the improved facilities, we are delighted to see increased interest and use of the preserve by faculty and students who are exploring their expanded options for teaching and research. For more than 15 years, the Max Planck Institute team has made effective use of the unique resources at the preserve, and now more than 7 BYU faculty and hundreds of our students are using the Lytle Preserve as a remarkable and valuable outdoor learning and research laboratory.

As always, we appreciate the college and university administrations for their ongoing support, particularly during the museum expansion and remodel. Wadman Corporation, Jacoby Architects, and our own Physical Facilities team have been professional in every way, and our friends and donors have been remarkably supportive. To say the least, the museum family is deeply grateful.
Early in 2013 (January 5th) the museum lost a dear and remarkable friend—V. Jay Wadman. Later in the year, June C. Wadman, Jay’s wife of almost 68 years, also passed away (April 21st). In recognition of their generous support, we are dedicating the museum’s 2013 Annual Report to Jay, June, and their family. Jay was born on March 12, 1927, in Brigham City, and June was born in Ogden on June 16, 1928. Jay and June were married on February 16, 1945, while Jay was serving in the United States Navy. Brother and Sister Wadman have 6 children, 26 grandchildren, and a host of great grandchildren.

Jay grew up working with his father, Ben Wadman, in the family construction business. In 1951, after returning from service in the navy, Jay started his own construction company—Wadman Corporation. Jay began by doing remodel jobs locally, including small construction projects at Hill Air Force Base. Building on his father’s reputation for honesty and integrity, Jay’s business progressed steadily, eventually spreading across the Intermountain Region and into California.

June’s life was focused on her family! She loved her role as wife, mother, and homemaker. She cultivated practical skills, such as crocheting and knitting, and brought the gift of music into her home by playing the piano and organ. She was a wonderful cook and shared her talents and skills generously with family and friends. Throughout her life, she rendered faithful service in the church and community.

The Wadman family has been involved in philanthropic work, supporting American Indian Services, a foundation committed to providing scholarships to Native Americans. Annually, the foundation awards more than 2000 scholarships. The Wadman family also contributed generously to the expansion of the M.L. Bean Life Science Museum, with Wadman Corporation serving as the general contractor for construction of the new 30,000 SF addition to the east side of the original building.

Jay and June’s legacy will continue to bless others for years to come. Their children and grandchildren are committed to carrying on their legacy of community support by reaching out to make a positive difference in the lives of neighbors, friends, and many others!
WHAT ABOUT LICHENS?

The diversity and complexity of life on earth is extraordinary, and to better understand how living things interact with each other, as well as their ecological roles and origins, biologists partition plants and animals by specialized disciplines. One of these disciplines, lichenology, involves the study of a unique group of fungi that form complex symbiotic relationships with a photosynthetic partner (either an alga or a cyanobacterium). This relationship is nothing short of remarkable: the photosynthetic partner produces food through photosynthesis, which it delivers generously to the fungus. The fungal partner then uses those resources to build a greenhouse-like “home” for the photosynthetic partner while providing the basic pest and environmental controls essential to keeping the photosynthetic partner healthy and productive.

Lichens are known to occur in virtually all natural habitats, ranging from hot deserts to the boreal forest, to the tropics, to the Arctic tundra. They are commonly found on a variety of natural substrates, including bark, rocks, and soil, as well as a host of human-produced substrates, such as concrete, rubber, canvas, plastic, glass, various metals, and asphalt, to name a few. Lichens are rich in secondary chemicals which serve diverse functions that include enhanced water storage, light regulation, and deterrence of herbivores. Some lichen compounds are being tested for their anticancer and antibacterial properties. Lichens are commonly confused with mosses. The two are not closely related genetically, but they are often grouped together because they typically occupy similar habitats. Lichens are generally overlooked by most people, but if you look for green and orange, and brown colors on rocks and trees in nature, you have more than likely discovered lichens. If you use a 10X hand lens, you might even be able to see the minute details associated with the structure of lichens, including their disk-shaped fruiting bodies.

Lichens have been used by humans for a variety of purposes. For hundreds of years, some lichen chemicals have been used to dye wool, and lichens are used in some cultures as a food source. Anyone who has collected model trains has likely used lichens to help create a realistic landscape for their
train community. More recently, lichens are being used by scientists to monitor air pollution effects in national parks and wilderness areas. Because lichens accumulate air pollutants washed from the air by any form of precipitation, they provide an accurate record of the kinds and quantity of pollutant elements in the atmosphere. Because many lichens are sensitive to a range of air pollutants, they provide an early indication of potential air pollution effects on natural systems.

The Herbarium of Nonvascular Cryptogams at the M.L. Bean Life Science Museum houses a large collection of lichens and bryophytes that contains more than 100,000 specimens from all over the world, with a particular emphasis on specimens from the western United States. Researchers at BYU have focused on the use of lichens as biomonitors of air quality for more than 35 years. The herbarium also includes a collection of more than 1500 archival tissue samples from across the Intermountain Area. All of these samples have been analyzed for more than 25 potential air pollutants as part of an extensive network of more than 400 air-quality biomonitoring reference sites in the nation's wilderness areas and national parks.

EXHIBITS

The year 2013 was a busy year for the exhibits committee. They spent most of their time designing and developing 25 new exhibits for the expanded and remodeled museum spaces. Each exhibit required a detailed plan and budget proposal that were submitted to the museum’s Executive Committee for review and approval. The committee met weekly and developed detailed plans for the following exhibits:

1. Why Insects?
2. Protect Your Planet – the new theme for the museum
3. Whooo Lives Here? – a children’s area
4. Our Living Planet
5. Because of Plants
6. Life Submerged (Marine & Freshwater)
7. Connections
8. Life on Top: Apex Predators
9. Our Sacred Stewardship

The Exhibits Committee was able to move into their new workspace in October 2013. This space includes a conference room with whiteboards covering three walls so they can easily track plans and exhibit-related progress each week. The space also includes new design and taxidermy studios, as well as a new construction shop and large paint booth. The committee also researched and eventually hired several outside vendors to fabricate various components for the museum’s new exhibits, including an 8-foot globe of the world with high-definition satellite images, a coral reef, and a 30-foot ponderosa pine!
EDUCATION

With the closure of the museum, 2013 was a year committed to improving our practice as an education group. We have continued with our performance reviews three times a year to provide our student educators with valuable feedback about the quality of their outreach presentations. These reviews have included watching and analyzing video performances of live-animal shows and discussing ways for improvement.

In addition to helping our student employees improve, we have also inventoried our loan collection including databasing, labeling, and imaging all objects. We also continued to loan our bio-boxes to educators in the partnership school districts. The Ecosystems Bio-box was checked out 9 times and the Adaptations Bio-box was checked out 11 times. Many teachers also made use of our Bio-box delivery service.

We have also made our outreach live-animal shows more available to our patrons, increasing our daily quota from 1 to 2. During 2013, we scheduled more than 350 live-animal shows (333 outreach events, including free FHE shows, and 17 webcasts).

In 2013 we also sponsored five Nature Experienceships: “Birding” with Merrill Webb, “Conifers” with Larry St. Clair, “Insects” with Shawn Clark, “Quaking Aspens” with Sam St. Clair, and “Wild Edibles” with Tom Smith. With the museum closed during the summer of 2013, we also continued with our Wildlife Hour at 4 local libraries (American Fork, Pleasant Grove, Orem, and Springville).
Research by BYU faculty and students

It is hard to appreciate the complexity of the Mojave Desert ecosystem until you try to predict its behavior. This complexity is highlighted by research presently conducted at the Lytle Ranch Preserve to understand what causes the desert to burn and how resilient it is to fire. The Desert Fire-Mammal-Precipitation study, a USDA-funded project, has brought together faculty and students who study small mammals, soil science, entomology, and plant ecology. Undergraduate and graduate students have been monitoring ecosystem responses to an experimental burn conducted at Lytle Ranch in 2011. One of the key contributors to this work has been Rory O’Connor, a graduate student advised by Sam St. Clair and Richard Gill. His work focuses on the invasive annual grass *Bromus rubens* (red brome). This grass is primarily responsible for the increase in fire frequency and intensity in the Mojave Desert. Rory measured the abundance and mass of red brome in burned and unburned Mojave Desert landscapes using the large experimental infrastructure installed in 2011 and 2012 on one of the upland areas at the Lytle Preserve. In this experiment, rainfall exclusion shelters and water-addition plots create conditions that range from severe drought to wet conditions. There are also large plots where small mammals have been removed and are kept from returning by small fences.

Rory was particularly interested in measuring how the red brome abundance—which determines the likelihood of the desert burning—changed
in response to small mammals and the amount of precipitation. One result was particularly surprising. He found that burning did not specifically increase red brome abundance; however, he did find an interesting interaction with how red brome responds to precipitation and small mammal abundance. Under drought and severe drought conditions, small mammals did not influence red brome abundance. Red brome abundance remained low as long as the ecosystem had below-average rainfall. The low abundance of red brome, with below-average rainfall, was also not influenced by the presence or absence of small mammals. However, when water was experimentally added to simulate a wet year, red brome increased exponentially, resulting in conditions primed for fire. The key insight in the study was the extent to which this response could be mediated by small mammals. In plots where small mammals were present, red brome response to added rainfall was suppressed. This complex response shows that some things that we assumed were key controls over red brome abundance, such as fire history, may not be as critical, whereas other yet unconsidered factors, like rodent abundance, may exert a strong control over desert responses to fire. This work further highlights the key insights that follow when scientists and students across disciplines come together in a place like Beaver Dam Wash and the Lytle Ranch Preserve to address complex and pressing research questions. Without the collaboration of plant ecologists, global change biologists, and mammalogists we would never have discovered the hidden interaction that controls this ecosystem’s resilience to disturbance.

Rick Gill is professor of biology and one of several BYU faculty members conducting long term research at the Lytle Preserve. Rick generously provided images highlighting his work at the preserve.

Research by Ian Baldwin and the Max Planck Institute

The research goal of the Department of Molecular Ecology at the Max Planck Institute for Chemical Ecology in Jena, Germany, is to understand how plants survive in nature. Few agricultural plants can survive even a single growing season without being pampered with fertilizers, water, and protection from competitors, pathogens, and herbivores. We have bred agricultural plants to do amazing things that their wild ancestors could not, such as producing abundant food for us. However, those same selectively bred varieties have simultaneously become environmentally “challenged.” Survival in the real world requires complex traits that quantitatively adjust a plant’s metabolism to meet the demands of growth, defense, and reproduction. These traits are essential for plants to maximize their production of “grandchildren” and thereby their Darwinian fitness. Surprisingly, we know very little about the genes that make this possible. Our objective is to manipulate ecological interactions in nature to identify traits that are demonstrably important for an organism’s fitness within the complexity of interactions that occur in nature. We have developed a rapid and efficient transformation system for our model plant, Nicotiana attenuata (Solanaceae), which is native to southwestern Utah. The Lytle Ranch Preserve provides us with a unique opportunity to study the diversity and characteristics of chemical signals that mediate interactions between
organisms and their environment under real world conditions in the plant's native habitat. By melding the tools of modern analytical chemistry and molecular biology with those of old-fashioned fieldwork, we are able to examine the molecular mechanisms by which plants survive adverse environmental conditions and ensure their survival to produce “grandchildren.” This includes the discovery of a sophisticated suite of herbivore-resistance traits, including tritrophic interactions (predators), fungi, and bacteria that interact with the roots of \textit{N. attenuata}, as well as traits important for interactions with floral visitors and traits that could form the basis for modern and environmentally friendly agricultural practices. In 2014 and 2015, we will focus on plant photoreceptors, the role of arbuscular mycorrhiza, and the natural history of our model plant, \textit{Nicotiana attenuata}.

\textbf{Ian Baldwin} is director of the Max Planck Institute for Chemical Ecology at Jena, Germany. Dr. Baldwin has conducted research at the Lytle Preserve for more than 15 years.

\textbf{Student mentoring – Andrew Lybbert}

The resources and opportunities available to students through the Monte L. Bean Life Science Museum have had an important influence on my future career. My training and development as an undergraduate and graduate student have been significantly influenced by the opportunity to work with the curators, collection managers, and the research collections available in the museum. While pursuing an undergraduate degree in biology my fascination with insects was initially cultivated in an entomology class taught by Dr. Michael Whiting. This class made extensive use of the museum's insect collection. The size and diversity of the collection led me to pursue a mentoring opportunity in the museum with Dr. Shawn Clark. In addition to teaching me practical curatorial skills, Dr. Clark encouraged me to explore the collection and facilitated my growing interest in insect pollinators. These important museum experiences ultimately contributed to my decision to study plant-pollinator interactions as a graduate student at the museum's Lytle Ranch Preserve.

As a graduate student, I continue to pursue my interests in pollination ecology. My research has centered on questions dealing with fire effects on the complex relationships and interactions between Mojave Desert perennial plants and their insect pollinators. For my thesis I
have been quantifying flower and fruit set for eight desert species (more than 500 individual plants) across multiple sites and burn treatments. In addition, in order to assess fire effects on the flower visitor community structure, I have also been sampling the insect communities that forage in and visit flowers of specific plant species in burned and unburned areas. Although results vary between species and across years, plants surviving in burned areas generally produce significantly more flowers and fruits than individuals in unburned areas. Pollinators seem to actively forage in burned areas, including small isolated “island” communities.

The Lytle Preserve has been an ideal location for my research for several reasons: (1) The diversity of plant and animal species native to the preserve provide an important group of ecologically significant species characteristic of the Mojave Desert; (2) in recent years, several wildfires have burned over large sections of the BLM-administered land adjacent to the preserve, providing multiple independent sampling locations for fire disturbance research; and (3) my fieldwork was conducted for weeks at a time over three years, and the amenities and management policies of the preserve have provided invaluable logistical support. I know that my academic progress and success have been directly influenced by access to the unique resources available at the museum and Lytle Ranch Preserve.

Andrew Lybbert received his BS in Biology and is now pursuing an MS degree in the Department of Plant and Wildlife Sciences at BYU. Andrew plans to pursue doctoral studies in pollination biology after finishing his degree program at BYU.
Robert Johnson, Collection Manager—Stanley L. Welsh Herbarium

Dr. Robert Johnson joined the Monte L. Bean Life Science Museum as Herbarium Collections Manager in January 2013. Robert brings a wealth of botanical experience to the herbarium, and we welcome him to the museum family. Robert graduated with a BS in Botany from Brigham Young University in 1991, followed by an MS in 1993 with an emphasis in Plant Ecology under the direction of Dr. Kimball Harper, and a PhD in 2008 also in Plant Ecology under the direction of Dr. Val Anderson. Interspersed with his schooling were employment activities that included work as a natural resources specialist for the US Army Dugway Proving Grounds, a founder and partner in a successful native plant nursery, a research associate in restoration ecology, and a land manager and conservation specialist for the Southern Nevada Water Authority.

Robert is an excellent field botanist and his diverse background and interests bring new perspectives and dimensions to the herbarium's expertise with the native plants of the Intermountain West. His extensive experience in working with students, managing projects, and interfacing with the public are just some of his talents that are already benefitting the herbarium, the museum, and the university.

Since joining the herbarium, Robert has worked with over a dozen students in research and herbarium curatorial activities. He has collected range extensions and county records for several plants, updated the taxonomy of various groups, annotated
hundreds of specimens, and helped several students and faculty with their plant identification needs. Robert is actively involved in the herbarium’s efforts to database all of its collections and to make these records publically accessible via the internet (see the progress at www.intermountainbiota.org). He has also taken the lead on herbarium efforts to provide longitude and latitude data for each specimen, an activity that opens up new kinds of taxonomic and ecological questions that can be addressed with herbarium data.

Outside of the herbarium, Robert and his wife, Jeanne, make their home in Woodland Hills and are parents to four children.

New Wet Collections Facility

Since the museum opened in the spring of 1978, the museum’s large and valuable alcohol-preserved collections (fish, amphibians, reptiles, aquatic insects, and some mammals) have largely been stored, due to weight issues, in the museum basement. In recent years, changing building codes and significant increases in the volume of the collections made it apparent that the “wet collections” needed to be housed in a separate, code-compliant facility. With the expansion of the museum, the university administration decided it was time to solve the wet collections problem by constructing a 2300 SF underground wet collections storage facility attached to the west side of the existing building. The new Wet Collections Facility was completed in September 2013 and includes a new high-density storage system for more efficient space use and significantly improved seismic protection. The new facility accommodates the current collections and provides 20–25 years of future growth for these large and valuable research collections.

Student Mentoring – Emma Mortensen

I volunteered with Dr. Sites in the Herpetology (reptiles and amphibians) collection. I started out cataloging and re-jarring some of the museum’s specimens. It was fascinating to learn the history behind the various lizards and snakes that have been deposited in the museum’s research collection over almost a century! Soon thereafter, I was given the opportunity to work with César Aguilar (Dr. Sites’s PhD student) and study specimens of a new Liolaemus lizard species he discovered in Peru. This project resulted in coauthorship on a published paper describing several new species.

I have thoroughly enjoyed working with Dr. Sites as a part of my undergraduate mentoring experience in the museum’s research collections! I have gained invaluable experience in herpetology, now my chosen field of study. It has given me a head start on my graduate studies by allowing me to conduct research and coauthor a scientific publication, which is an unusual opportunity for an undergraduate and a remarkable break for a freshman! It was also a wonderful networking opportunity. I was able to meet
and become familiar with many experts in the field as they have come to BYU to work with Dr. Sites. Because of my experience working with Dr. Sites, I have a clear understanding of what I want to do for my career.

Emma Mortensen is a sophomore majoring in biology and working with Dr. Jack Sites in the museum’s herpetology collection. Emma plans to pursue a graduate degree after graduation from BYU.

WESTERN NORTH AMERICAN NATURALIST

The museum’s quarterly natural history journal marked its 74th year of publication in 2013. We reviewed 143 original submissions and published 646 printed pages, which included a monograph volume containing extensive treatments of the lichens of Wyoming, bats of the Wildcat Hills, green microalgae in Joshua Tree National Monument, speciation of black flies, and taxonomy of pebblesnails.

In May, our two senior student interns, Megan Gebhard and Michelle Lyons, received museum support to attend the annual meeting of the Council of Science Editors in Montreal, Canada, to receive valuable industry training in editing. They were each invited by council officers to write informative session reports to benefit members who were unable to attend the meeting or who were attending concurrent sessions. Those reports—one on editorial decision-making and the other on transforming journal content for the public’s use—were published in the Science Editor (vol. 36, iss. 3, pp. 81, 96). We feel that BYU was well represented by the efforts of these students.

In 2013, we also worked with the Harold B. Lee Library digital collections team to complete an upgrade to our Open Journal Systems software. This upgrade brings great improvements to the journal’s online accessibility and security.

We are looking forward in 2014 to completion of a monograph volume on the natural history of the California Channel Islands and to a significant office remodel associated with the ongoing construction and remodel of the museum.
ACKNOWLEDGEMENTS

The task of effectively and efficiently preparing the museum for reopening has been and will continue to be a daunting task for the museum family. For the last year, we have spent most of our time trying to keep the museum semifunctional in spite of construction on the addition and remodeling of the existing building while actively planning, designing, and constructing more than 25 new exhibits that must be in place before the museum can reopen. Construction-related conditions have often been challenging, with a steady blitz of some combination of noise, odors, vibration, dust, temporary relocation, and temperature fluctuations. The promise that things will ultimately be much, much better has often inspired us to hang on and endure all things well. In the end, the dedication, hard work, skill, and absolute commitment of the museum staff has been, as always, nothing short of remarkable. In the midst of all the challenges, we find that we have much to be thankful for: each other, support from the College of Life Sciences and the BYU administration, and the opportunity to work with our great colleagues from Wadman Construction, Jacoby Architects, and the BYU Physical Facilities team. The hours have been long and at times overwhelming, but we have come out the better for it time after time after time. Sincere thanks to Ken, Randy, Patty, Clark, Katy, Heriberto, Marta, Janene, Robert, Shawn, Soli, Holly, Monica, Leigh, Skip, and our faithful host of students—great job!!

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Ian Baldwin, Research Associate – Lytle Ranch Preserve


Richard Baumann, Emeritus Curator of Insects


Shawn Clark, Senior Collection Manager of Insects


Michael Hastriter, Research Associate – Entomology


Leigh Johnson, Curator of Vascular Plants


Randy Larsen, Assistant Curator of Birds


Riley Nelson, Assistant Curator of Insects

Duke Rogers, Curator of Mammals

Jack Sites, Curator of Herpetology
Larry St. Clair, Curator of Nonvascular Cryptogams


Stanley L. Welsh, Emeritus Curator of Vascular Plants


Clayton White, Emeritus Curator of Birds


Michael Whiting, Curator of Insects


