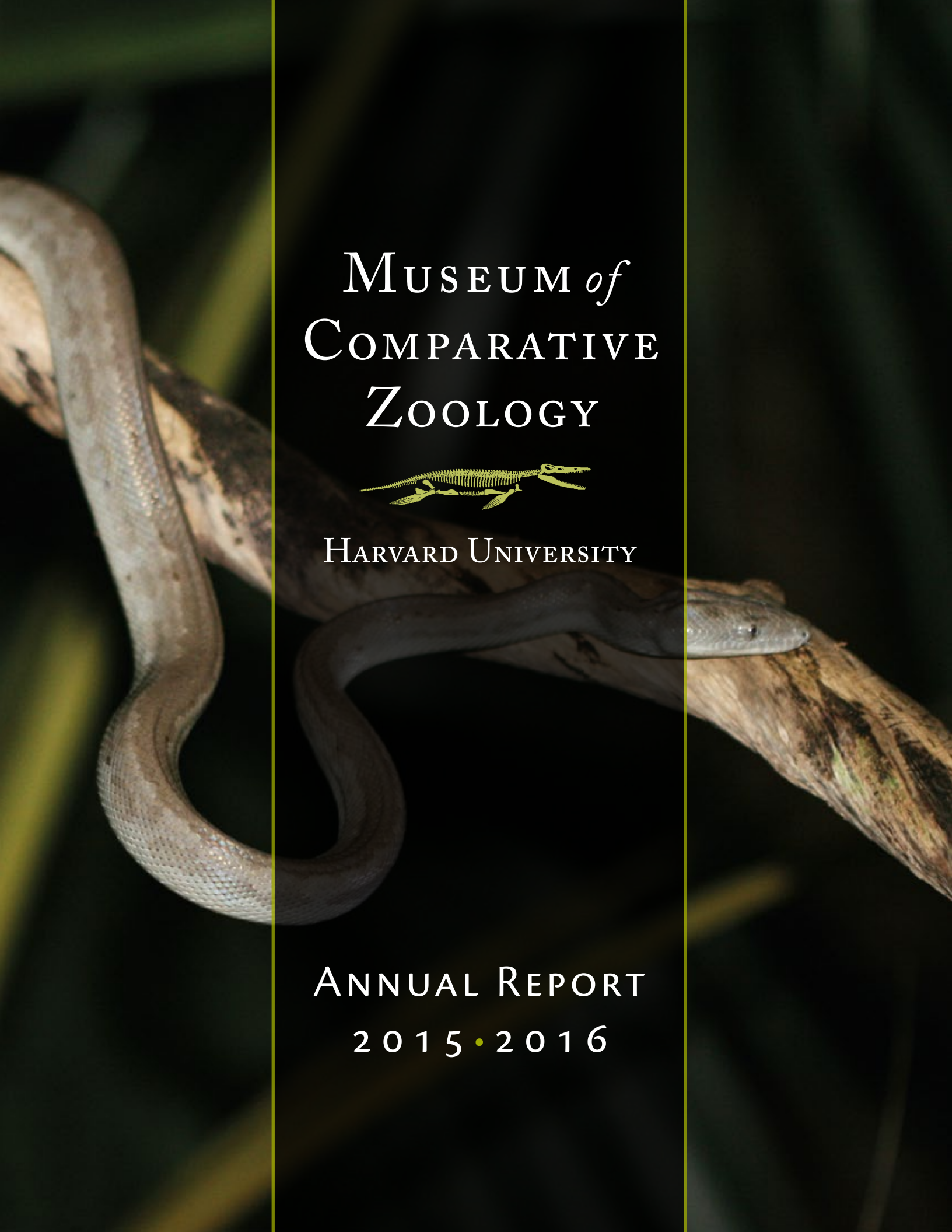


Museum of Comparative Zoology

Harvard University

Annual Report
2015 • 2016


OEB 115: Evolutionary Developmental Biology
Mansi Srivastava, Matt Harris, Cliff Tabin
TF: Sam Church
A Cellular Perspective on Evo-Devo

Director's Message

This past year we celebrated marine biology at the MCZ and the completion of several facilities renovation projects, some of which had been in the works for years.

Harvard's collection of Blaschka glass marine invertebrates made its literary debut in *Sea Creatures in Glass.* This book offers a brief history of the Blaschka family's manufacture of remarkable, lifelike glass models and details the decade-long conservation process that restored and stabilized MCZ's priceless collection. Eighty-eight pages of exquisite, detailed color photographs follow the text.

Marine Life in the Putnam Family Gallery, a permanent exhibit in the Harvard Museum of Natural History, opened in 2015. The exhibit features specimens from several MCZ collections and modern models, which both immerse visitors in an underwater world and feature contemporary research and conservation efforts. We are tremendously grateful to the Putnam family for their generous gift, which supported this new installation.

In the spring, we celebrated completion of the MCZ's state-of-the-art collections facility in the adjacent Northwest Building with a dedication and open house where hundreds of guests from the Cambridge campus and beyond toured the two floors of storage, teaching and lab spaces. Collections staff spent weeks preparing for the event, wowing visitors with a rainbow-like, 15-foot display of birds and offering a rare glimpse of the Blaschka glass marine invertebrates in their storage cases, among other crowd-pleasers.

Collection rooms were not the only spaces to be modernized and upgraded—the MCZ renovated two classrooms, a conference room, and a staff/student lounge. The charm of our 19th-century main building was maintained in all spaces, while transforming them into bright, climate-controlled rooms with modern presentation technology and better functioning—and much more comfortable—tables and chairs.

Sadly, we lost one of our MCZ Faculty members this year. Dr. John Constable was a longtime member of the board of directors, whose existence dates back to the founding of the museum in 1859. A remarkable man in many respects, John came from a distinguished British family. His father, a distant relative of the English Romantic painter John Constable, immigrated to the U.S. to become curator of the (then) Boston Museum of Fine Arts. John began his association with the MCZ as a teenager in the 1940s, during World War II, when he began a taxonomic study of the reptiles of India under the supervision of herpetology curator Arthur Loveridge and in response to a request from the U.S. defense department, which needed help in producing an identification guide to poisonous snakes.

Finally, we initiated a formal search for a faculty member/Curator of Invertebrate Paleontology to fill a position that has been vacant for several years. At the time this report goes to press, I am optimistic that we will welcome a new colleague in the 2018–2019 academic year.

As you read more about the MCZ's newsworthy research and projects, remember that none of it would be possible without the ongoing efforts of our many faculty-curators, staff, students and postdocs, as well as the critical support we receive from the Harvard administration and dedicated alumni. We look forward to reporting more next year.

Melissa Aja

James Hanken
Director

About the Cover:

The newly discovered Conception Bank silver boa (*Chilabothrus argentum*). Photo by R. Graham Reynolds.

Opposite page: One of the MCZ's recently renovated classrooms. Photo by Melissa Aja.

Highlighting the Importance of Collections

Harvard's Northwest Building provides more than ordinary storage for many collections of the MCZ.

"MCZ's new facility in the Northwest Building is carefully designed to provide a secure, temperature- and humidity-controlled space to preserve six million specimens,"

Melissa Aja

says Director James Hanken. "It facilitates the use of these collections for research and specimen-based teaching and offers faculty, collections staff, visitors and students a pleasant work environment."

Planning for this space began long before construction started. Consultant Jeff Weatherston of Toronto-based WeathersonBruer Associates spent years performing an extensive space-needs analysis to determine how to best accommodate collections destined for the facility. Now, the space is filled with all or part of seven collections accumulated during the MCZ's 157-year history.

The building houses portions of the Invertebrate Paleontology, Ornithology, Vertebrate Paleontology, Malacology, Mammalogy, Entomology and Invertebrate Zoology collections, plus the Blaschka glass animals and the historic Harvard Embryological Collection. Specimens are housed in custom-designed steel cabinets that maximize use of available space, including those for oversized specimens such as elephant hides, kangaroos and ostriches.

A wall-mounted pegboard system creatively stores hundreds of mounted bird specimens prepared for exhibition, and precise climate control suppresses insect infestations without the use of pesticides. Preparation spaces have specialized equipment that makes it easier and safer for staff to work with particular types of specimens. The Paleontology lab has rock saws, dust collectors and giant fume hoods, while the Vertebrate Zoology lab is equipped to process tissue samples and store them cryogenically. To date, the environmentally friendly, energy-efficient 50,000-square-foot build-out has received nine LEED certifications.

In March 2016, the facility's official grand opening attracted more than 200 MCZ personnel, the MCZ Faculty, and members of the Harvard administration and community. Director James Hanken and Faculty of Arts and Sciences Dean Michael D. Smith addressed the visitors, who then enjoyed refreshments and collection tours.

Melissa Aja

MCZ Faculty-Curators

Andrew A. Biewener

Charles P. Lyman Professor of Biology
Director, Concord Field Station

Prof. Biewener's research focuses on understanding the biomechanics, neuromuscular control and energetics of animal movement on land and in the air.

His goal is to understand general principles that govern the biomechanical and physiological design of vertebrate animals related to their movement in natural environments.

Tony Rinaldo

Scott V. Edwards

Professor of Organismic & Evolutionary Biology
Alexander Agassiz Professor of Zoology
Curator of Ornithology

Prof. Edwards' research focuses on the evolutionary biology of birds and related species, combining field, museum and genomics approaches to understand the basis of avian diversity, evolution and behavior. Current projects utilize genomics technologies to study comparative genomics and the evolution of flightlessness in birds; phylogeography and speciation of Australian and North American birds; and the genomics of host–parasite co-evolution between house finches and a recently acquired bacterial pathogen, *Mycoplasma*.

Stephanie Mitchell

Brian D. Farrell

Professor of Biology
Curator of Entomology
Director, David Rockefeller Center for Latin American Studies

Prof. Farrell's research is broadly concerned with the evolution of ecological interactions between host plants and animals and their parasites, such as insects and other tiny consumers. His current projects include applying next-generation sequencing to speciation and phylogenetic studies of associated species, documenting biodiversity in the Dominican Republic, and repatriating digital information from scientific specimens of insects and fossils in museums to their countries of origin.

Gonzalo Giribet

Professor of Organismic & Evolutionary Biology
Alexander Agassiz Professor of Zoology
Curator of Invertebrate Zoology

Prof. Giribet's primary research focuses on the evolution, systematics and biogeography of invertebrate animals, including the use of morphology and next-generation sequencing techniques. Current projects in the Giribet lab include the evolution of orb-weaving spiders and other arachnids, and systematics and biogeography of arthropods, mollusks and onychophorans, among other groups. He is also interested in the use of genomic-level data for inferring phylogenies.

© Casey Dunn

Catherine Weisel

James Hanken

Professor of Biology
Alexander Agassiz Professor of Zoology
Curator of Herpetology
MCZ Director

Prof. Hanken utilizes laboratory-based analyses and field surveys to examine morphological evolution, developmental biology and systematics. Current areas of research include the evolution of craniofacial patterning; the developmental basis of morphological novelty; biodiversity informatics; and systematics and evolution of neotropical salamanders. Prof. Hanken also serves on the Executive Committee of the Encyclopedia of Life (eol.org).

Stephanie Mitchell

George V. Lauder

Professor of Biology
Henry Bryant Bigelow Professor of Ichthyology
Curator of Ichthyology

Prof. Lauder's research focuses on the biomechanics of fishes and the development of robotic models for studying aquatic locomotion.

His current studies focus on the function of shark skin and other surface structures, the role of flexibility in improving the efficiency of aquatic propulsion, and how fishes control body and fin position as they maneuver through obstacles. Additional broad interests include biological fluid mechanics and theoretical approaches to the analysis of form and function in organisms.

Gretchen Ertl

Hopi E. Hoekstra

Professor of Organismic & Evolutionary Biology
Professor of Molecular & Cellular Biology
Alexander Agassiz Professor of Zoology
Curator of Mammalogy
Howard Hughes Medical Institute Investigator
Harvard College Professor

Prof. Hoekstra combines field and laboratory work to understand the evolution of mammalian diversity from morphology to behavior. Her research focuses on the genetic basis of adaptive variation—identifying both the ultimate causes and the proximate mechanisms responsible for traits that help organisms survive and reproduce in the wild. Research in the Hoekstra lab integrates ecological, behavioral, genetic and molecular approaches.

Rose Lincoln

Jonathan B. Losos

Monique & Philip Lehner Professor for the Study of Latin America
Professor of Organismic & Evolutionary Biology
Curator of Herpetology

Prof. Losos' research focuses on the behavioral and evolutionary ecology of lizards, specifically how lizards interact with their environment and how lizard clades have diversified evolutionarily.

His laboratory integrates approaches from systematics, ecology, behavior, genetics and functional morphology, taking both observational and experimental approaches in the field and in the laboratory.

Jon Chase

James J. McCarthy

Professor of Biological Oceanography
Alexander Agassiz Professor of Biological Oceanography
Acting Curator of Malacology

Prof. McCarthy's research focuses on factors that regulate the processes of primary production and nutrient supply in the ocean. Using field studies and modeling, Prof. McCarthy and his group examine the effects of seasonal or interannual climate change on marine life from plankton to whales.

Kris Snibbe

Naomi E. Pierce

Sidney A. & John Hessel Professor of Biology
Curator of Lepidoptera

Prof. Pierce's research focuses on the behavioral ecology of species interactions, particularly insect/plant associations, and symbioses between ants and other organisms, including bacteria, fungi, plants and caterpillars of butterflies in the family Lycaenidae. Prof. Pierce is interested in how parasitic and mutualistic life histories can influence the evolutionary trajectories of each partner.

Paul Whatmough

Stephanie E. Pierce

Assistant Professor of Organismic & Evolutionary Biology
Curator of Vertebrate Paleontology

Prof. Pierce's research is focused on major morphological and ecological transitions in vertebrate evolution through an examination of the fossil record.

Her work tends toward 3-D modeling and experimentation of the musculoskeletal system, with particular attention to the link between form and function. Current projects include the fin-to-limb transition, the evolution of the mammalian backbone, and the origin of the avian neck.

Jean-Francois Bertrand

Robert M. Woollacott

Professor of Biology
Curator of Marine Invertebrates

Prof. Woollacott's research focuses on aspects of marine invertebrate life history, such as synchronization of reproductive events and ecology and physiology of larvae. Topics of particular interest include larval dispersal and population connectivity, as well as human impacts on the distribution of marine organisms.

Isaac Orderberg

Mansi Srivastava

Assistant Professor of Organismic & Evolutionary Biology
Curator of Invertebrate Zoology

Dr. Srivastava's research focuses on understanding the evolution of animal development and regeneration. Her group utilizes the three-banded panther worm, *Hofstenia miamia*, which Dr. Srivastava has developed as a new acoel model system. Acoels represent the earliest lineage of animals with bilateral symmetry, which allows the study of genetic mechanisms that span 550 million years of animal evolution. Current projects in the lab range from identifying gene regulatory networks for regeneration to determining the embryonic origins of pluripotent stem cells.

MCZ Emeriti

Justin Ide

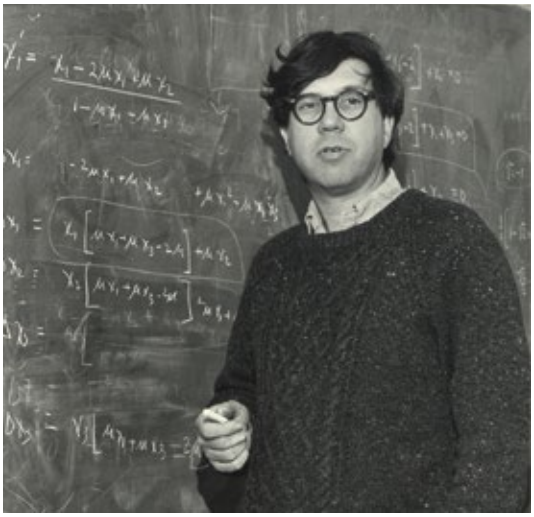
A. W. "Fuzz" Crompton

Faculty-Curator, Emeritus
Fisher Professor of Natural History, Emeritus

Prof. Crompton, former Curator of Mammalogy, was the Director of the MCZ from 1970 to 1982 and the former Director of the Peabody Museum of Natural History, Yale University, and the South African Museum, Capetown. His primary research interests are the origin and evolution of mammals, functional anatomy, neural control and evolution of feeding in recent and fossil vertebrates. Prof. Crompton received two Guggenheim fellowships for his research on vertebrate paleontology and functional morphology and in 2011 received the Romer-Simpson Medal from the Society of Vertebrate Paleontology.

Richard C. Lewontin

Professor of Biology, Emeritus
Alexander Agassiz Professor of Zoology, Emeritus



An evolutionary geneticist, Prof. Lewontin pioneered the field of molecular population genetics by merging molecular biology and evolutionary theory, as well as the philosophical and social implications of genetics and evolutionary theory.

Prof. Lewontin's current research involves computer simulation and evaluation of statistical tests for selection. Among his many books are *The Genetic Basis of Evolutionary Change*; *Biology as Ideology: The Doctrine of DNA*; *Human Diversity*; and *The Triple Helix: Gene Organism and Environment*.

Beth Maynor Young

Edward O. Wilson

Honorary Curator in Entomology
Pellegrino University Professor, Emeritus

Prof. Wilson is considered the founder of sociobiology and evolutionary psychology and has developed the basis of modern biodiversity conservation. He has received many of the world's leading prizes in recognition of his research and environmental activism.

He was awarded two Pulitzer Prizes for his books *The Ants* (1990, with Bert Hölldobler) and *On Human Nature* (1978). Prof. Wilson received the TED Prize in 2007, where he articulated the concept of the Encyclopedia of Life, and the National Geographic Society's Hubbard Medal in 2013.

Courses in 2015–2016 Led by MCZ Faculty-Curators

Jonathan Losos

OEB 101: Biology of Mammals

Organismic and Evolutionary Biology

OEB 57: Animal Behavior
Naomi E. Pierce (and Bence P. Olveczky)
A review of the behavior of animals under natural conditions, with emphasis on both mechanistic and evolutionary approaches.

OEB 101: Biology of Mammals
Jonathan Losos
An introduction to the biology of mammals. Lectures and laboratories examine the morphology, systematics, natural history, behavior, ecology, evolutionary relationships and biogeography of all major taxa.

OEB 126: Vertebrate Evolution
Stephanie Pierce
A comprehensive survey of the origin and evolution of vertebrates through an examination of the fossil record, focusing on major events in Earth's evolutionary history, with an emphasis on anatomical and physiological transformations in fish, amphibians, reptiles, birds and mammals.

OEB 130: Biology of Fishes
George V. Lauder
Explores the unparalleled diversity of fish across different aquatic environments, including deep seas, intertidal zones, coral reefs, polar waters, the vast Amazonian basin and great East African lakes.

OEB 130: Biology of Fishes

Morgan Furze

George Lauder

OEB 130: Biology of Fishes

OEB 155r: Biology of Insects
Naomi E. Pierce (and Michael R. Canfield)
Introduction to the major groups of insects—life history, morphology, physiology and ecology—through a combination of lecture, lab and field exercises.

OEB 173: Comparative Biomechanics
Andrew A. Biewener
Explores how animals and plants contend with their physical environment, considering their biomaterial properties, structural form and mechanical interactions with the environment.

OEB 217: What Makes a Cat?

Stephanie Pierce

OEB 157: Global Change Biology
James J. McCarthy
Examines how natural and anthropogenic changes in the earth system are affecting the composition and the functioning of the world's land and ocean ecosystems.

OEB 167: Herpetology
James Hanken and Jonathan Losos
An introduction to the biology of amphibians and reptiles. Lectures and laboratories examine the morphology, systematics, natural history, behavior, ecology, evolutionary relationships and biogeography of all major taxa.

OEB 181: Systematics
Gonzalo Giribet
Introduces theory and practice of systematics, emphasizing issues associated with homology statements and alignments, methods of tree reconstruction and hypothesis evaluation.

OEB 190: Biology and Diversity of Birds
Scott V. Edwards
An introduction to the biology of birds. Covers the fossil record and theories for avian origins, physiology and anatomy, systematics, speciation processes, behavior, vocalizations, demography and conservation.

OEB 217: What Makes a Cat?
Stephanie Pierce
Explores the origin and evolution of cats through a mixture of literature discussions, cadaveric dissection and fossil observation. Discussions include evolutionary dynamics, ecomorphology, and feeding and locomotor performance.

OEB 234: Topics in Marine Biology
Robert M. Woollacott

Explores the fragility and resilience of marine life and ecosystems in the face of perturbations such as habitat fragmentation, land use change, anthropogenic climate change, pollution, alien species and unsustainable fishing practices.

General Education

Science of Living Systems 22: Human Influence on Life in the Sea
Robert M. Woollacott, James J. McCarthy

Over-harvested fish stocks, pollution and anthropogenic climate change affect the stability and productivity of marine ecosystems. This course asks what we need to know about the causes and effects of anthropogenic change to best protect marine ecosystems and ensure sustainable harvests from the sea.

Environmental Science and Public Policy

ESPP 90j: Environmental Crises, Climate Change and Population Flight
James J. McCarthy (and Jennifer Leaning)

Explores the consequences of population flight due to war, drought and famine in which climate change is a contributing factor, relating to the extent and permanence of environmental destruction wrought by these crises, people's attachment to their homes and ecosystems, the circumstances of departure, the destinations of refuge and the possibilities for return.

Graduate Courses Reading and Research

OEB 307: Biomechanics, Physiology and Musculoskeletal Biology
Andrew A. Biewener

OEB 310: Metazoan Systematics
Gonzalo Giribet

OEB 320: Biomechanics and Evolution of Vertebrates
George V. Lauder

OEB 323: Advanced Vertebrate Anatomy
Stephanie Pierce

Scott Edwards

OEB 190: Biology and Diversity of Birds

OEB 325: Marine Biology
Robert M. Woollacott

OEB 334: Behavioral Ecology
Naomi E. Pierce

OEB 355: Evolutionary Developmental Biology
James Hanken

OEB 362: Research in Molecular Evolution
Scott V. Edwards

OEB 367: Evolutionary and Ecological Diversity
Jonathan Losos

Scott Edwards

Freshman Seminar

FRSEMR 21R: The Evolutionary Transition from Dinosaurs to Birds: Fossils, Genomes and Behavior

Scott V. Edwards

Explores the dinosaurian origins of modern birds through exploration of Harvard's excellent collections of dinosaur fossils, skeletons and specimens of extant birds, and focused readings and discussions. The goal will be to gain a greater appreciation of dinosaur diversity and to better understand the deep origins of modern bird adaptations.

FRSEMR 22T: Why We Animals Sing

Brian D. Farrell

Investigates the sounds and structures of different kinds of acoustic animals—including birds, mammals, frogs and insects—and the different kinds of habitats in which they produce their songs and calls.

Life Sciences

LIFESCI 2: Evolutionary Human Physiology and Anatomy

Andrew Biewener, George V. Lauder (and Daniel E. Lieberman)

Explores human anatomy and physiology from an integrated framework, combining functional, comparative and evolutionary perspectives on how organisms work.

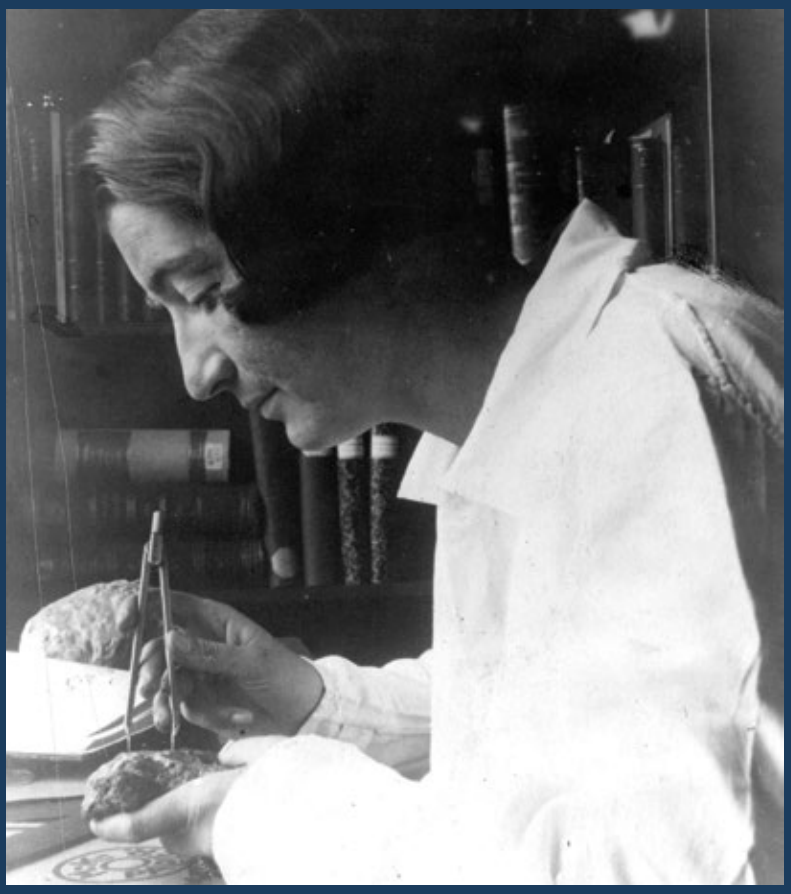
BIOS S-158: Study Abroad: Biodiversity of the Dominican Republic

Brian D. Farrell

Explores the interplay of ecological niches and evolutionary diversification in the organisms and habitats of a tropical island as a microcosm of the evolution of biodiversity on Earth.

OEB 130: Biology of Fishes

George Lauder



MCZ, Harvard University

MCZ History

In June 1938, MCZ paleontologist Alfred Sherwood Romer received a letter from a Boston psychiatrist. Was he willing to meet to discuss possible employment at the MCZ for her old schoolmate, Tilly Edinger?

Edinger was then a vertebrate paleontologist at the Senckenberg Museum in Frankfurt, Germany. Starting in the early 1920s, she had documented the structure of cranial endocasts, using these "fossil brains" to reconstruct the lifestyle of extinct vertebrates. Her seminal 1929 work, *Die fossilen Gehirne (Fossil Brains)*, had established her international reputation and the field of paleoneurology. Now, restrictive Nazi "racial laws" threatened both her job and her life.

Romer's subsequent actions paved the way for Edinger's safe departure from Germany and her eventual addition to the MCZ staff. Edinger worked happily at the MCZ for a quarter-century, writing widely on the evolution of the brain and the historical pattern of neural innovations. More than anyone else, she introduced the concepts of behavior, body size and phylogeny to the study of the brains of fossil vertebrates.

—*Emily A. Bucholtz, Wellesley College*

MCZ Research Making Headlines

Precious Metal

In this day and age, it is rare to discover large vertebrate species. It is even rarer to have one crawl across your face while sleeping. But that is exactly what happened to expedition leader **R. Graham Reynolds** during a Putnam-funded expedition to the remote Conception Island Bank in the Bahamas. It is especially remarkable that the new boa was found in 2015 in the Bahamas, a region that has been well studied since the 1860s, and by the MCZ since the 1880s. It is the first new species of West Indian boa to be discovered in 73 years.

The boa was christened the Conception Bank silver boa (*Chilabothrus argentum*), in large part because of its metallic silver scales, but also because it was first found in a silver palm (*Coccothrinax argentata*). Unlike the other ground-dwelling boas in the region, the silver boa lives in trees, moving agilely among the limbs and hunting birds.

The team, which included postdoctoral fellow **Anthony Geneva** and graduate student **Nick Herrmann**, who found the first boa, were able to hand-capture six live specimens for study, taking measurements, photos and DNA samples prior to their release.

In all, 33 of the meter-long boas were identified during three separate expeditions funded by the MCZ. The researchers have kept the exact location of this snake confidential in order to protect the species that, by using IUCN Red List criteria, they estimate to be critically endangered. The home of the silver boa is protected by its remote location, lack of human habitation and status as a national park. However, natural disasters, a population of feral cats discovered by the researchers and poaching for the pet trade are serious concerns.

R. Graham Reynolds

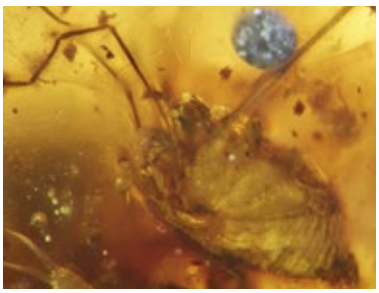
Reynolds RG, Puente-Rolón AR, Geneva AJ, Aviles-Rodriguez KJ, Herrmann NC (2016) Discovery of a remarkable new boa from the Conception Island Bank, Bahamas. *Breviora* 549:1-19

Arachnid Sex, Frozen in Time

Arachnid genitalia are an excellent way to identify not only gender, but also species, both ancient and extant. Most arachnids transfer sperm indirectly, without genital contact. Harvestmen (Arachnida: Opiliones), nicknamed daddy longlegs, are unusual in that they transfer sperm directly via copulation. The male's penis is retractable and spends most of the time inside the body, but as in the case of the spider genitalia, it yields crucial characteristics for species identification.

One of the biggest challenges in reconciling studies of fossil and modern harvestmen is the lack of visible male genitalia in fossils. However, a fossil harvestman from the Cretaceous Burmese amber of Myanmar, around 99 million years old, has been found preserved in a rather unique condition. This harvestman, frozen in time in the moments before copulation, provides the first example of a fully extended penis and offers valuable insights into an extinct species, *Halitherses grimaldii*.

The slender penis, with a spatulate, heart-shaped tip, and the specimen's large eyes, suggest that *H. grimaldii* represents a new, extinct family of harvestmen. **Gonzalo Giribet**, who together with Jason Dunlop described this Cretaceous species back in 2005, co-authored the new findings, presented in *The Science of Nature*.



Gonzalo Giribet

Gonzalo Giribet

Dunlop JA, Selden PA, Giribet G (2016) Penis morphology in a Burmese amber harvestman. *Sci Nat* 103:11

Answers from Anoles in Amber

Emma Sherratt

An enduring question in ecology is whether the structure of ecological communities—the group of interacting species living in the same place—can be stable over millions of years. Anole communities of the Caribbean have been a living laboratory for **Jonathan Losos**, but due to a dearth of anole fossils, answers to this question have remained elusive. Undeterred, Losos turned to specimens preserved in amber.

Caribbean anole specimens in amber—fossilized tree resin—are not easy to come by. Ten years ago, Losos heard of an anole specimen for sale by a private collector—only the fourth known to scientists—for one million dollars. Years later, Losos finally obtained access to the specimen and began to expand his search, leading to a collector in Italy and a museum in Germany. Losos managed to obtain 38 amber anole specimens from the island of Hispaniola to study, with one caveat—half of them could not leave Europe.

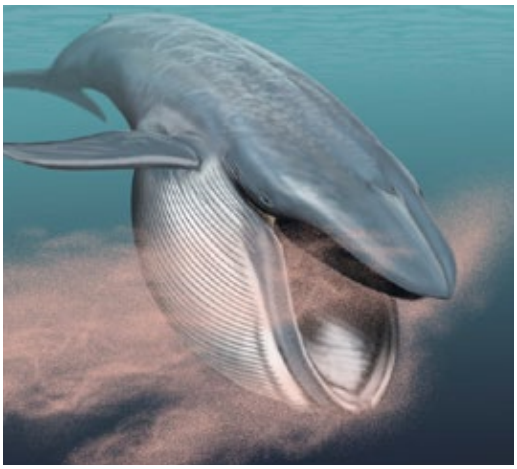
At the Natural History Museum in London, **Emma Sherratt**—at that time a postdoctoral researcher in the Losos lab—and others began scanning the amber with X-ray micro computed tomography (micro-CT). The surprise was that, in some cases, the intact lizard was preserved in the amber, preserving a perfect impression of the lizard down to the minute toepad scales. These toepad scales allow anoles to cling to surfaces, and the different types of toepad scales correlate with the lizards' ecological niche and help identify them as ground, bush or tree dwellers.

By examining fossilized scales as well as overall morphology, the researchers were able to determine that the lizard communities living on Hispaniola 20 million years ago were much the same as those that exist there today.

Lead author Sherratt was joined by co-authors **Rosario Castañeda**, Jonathan Losos and four former members of the Losos lab.

Sherratt E, Castañeda MdR, Garwood R, Mahler DL, Sanger TJ, Herrel A, de Queiroz K, Losos JL (2015) Amber fossils demonstrate deep-time stability of Caribbean lizard communities. *Proc Natl Acad Sci USA* 112:9961-9966

In the Belly of the Whale



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Five years ago, then-undergraduate **Annabel Beichman** and former MCZ Hrdy Fellow **Joe Roman** collected northern right whale feces in the Bay of Fundy to determine which microbes were present. The great whales are carnivores, often feeding on minute shrimp-like animals, and their microbiome—the microbes that live in their guts—in some respects resembles that of other carnivores, such as lions and tigers. DNA sequencing that Beichman conducted as part of her senior thesis revealed that the microbiome of right whales and other baleen species also shares traits with ruminants—plant eaters, like cows.

In a paper in *Nature Communications* by OEB graduate student **Jon Sanders**, Beichman, Roman, **James McCarthy**, OEB professor Peter Girguis and others, the researchers explore how these microbial communities allow whales to extract the most nutrition possible from their crustacean diet, including the chitin-rich exoskeletons, giving them access to about 10 percent more calories.

The ancestors of whales are the same as those of cows, camels, and other ruminants, and it is from these ancestors that they inherited the multichambered foregut that digests chitin in the way terrestrial herbivores digest cellulose.

In the future, the researchers hope to sample the microbial community in whales' stomach chambers and extend the study to toothed whales. Aquariums have shown interest in the research, in the hope that it may yield additional information about how to keep whales healthy in captivity.

Sanders JG, Beichman AC, Roman J, Scott JJ, Emerson D, McCarthy JJ, Girguis PR (2015) Baleen whales host unique gut microbiome with similarities to both carnivores and herbivores. *Nat Commun* 6:8285

A Blooming Partnership

Flowering plants—angiosperms—are found in numerous ecosystems, from tundra to tropical rain forests. The estimated 352,000 species are the result of nearly 130 million years of evolution, and that success is due in part to their symbiotic relationship with pollinators, especially insects such as bees, butterflies and long-proboscid flies. However, 105 million years ago during the Early Cretaceous, gymnosperms (such as pines, cypresses and cycads) were still dominant, and the wind was a more prevalent mode of pollination than it is today.

New research by Farrell lab NSF postdoctoral fellow **Ricardo Pérez-de la Fuente** and others has described new species from an extinct group of long-proboscid flies (family Zhangsolvidae) encased in Cretaceous amber from Spain and Myanmar. The amber preserved the delicate tubular proboscides, which the scientists were able to examine in minute detail through micro-CT imaging, and they were found to have adapted for siphoning nectar and possibly feeding on pollen. One Spanish specimen even had a pollen clump from gymnosperm, most likely a bennettitalean, attached to its body, offering direct evidence of a pollination relationship between ancient insect and plant species.

J.A. Peñas, AMBERIA project (IGME, UB)

The researchers note that if adaptations for pollination became highly specialized in certain insect lineages as a result of their interaction with gymnosperms over tens of millions of years, this may have predisposed these insects to develop similar symbiotic relationships with the emerging angiosperms, contributing to the evolutionary success of both flowering plants and their insect partners.

Peñalver E, Arillo A, Pérez-de la Fuente R, Riccio ML, Delclòs X, Barrón E, Grimaldi DA (2015) Long-proboscid flies as pollinators of Cretaceous gymnosperms. *Curr Biol* 25:1917-1923

Energy for the Run

For decades researchers thought that the primary function of the iliotibial (IT) band, which runs along the outside of the thigh from hip to knee, was to stabilize the hip during walking. However, new research by **Carolyn Eng** examines how the IT band acts as a spring to aid in locomotion, storing and releasing elastic energy to make running and walking more efficient.

The IT band is made up of fascia, an elastic connective tissue found throughout the body. Fascia is a sheath that encloses muscles, connects muscles to bone, and groups muscles that serve a similar function. The IT band is the largest piece of fascia in the human body and much more developed than that of chimpanzees.

To investigate the energy storage capacities of the IT band in humans and chimpanzees, Eng and colleagues first had to precisely describe which muscles attach to the IT band and where, then measure how much the IT band changes length during a series of movements. Finally, they created a computer model to measure how much energy is stored in running and walking, finding that the human IT band has the capacity to store 15 to 20 percent more energy than the similar structure in chimpanzees.

Eng and co-authors **Andrew Biewener**, research associate **Allison Arnold-Rife** and Daniel Lieberman describe the studies in the *Journal of Experimental Biology* and the *Journal of Biomechanics*. The researchers hope to expand their investigation to other primates adapted for running, and explore how understanding the IT band can help treat and avoid injury.

Eng CM, Arnold AS, Biewener AA, Lieberman DE (2015) The human iliotibial band is specialized for elastic energy storage compared with the chimp fascia lata. *J Exp Biol* 218:2382-2393

Eng CM, Arnold AS, Lieberman DE, Biewener AA (2015) The capacity of the human iliotibial band to store elastic energy during running. *J Biomech* 48:3341-3348

Highlights from the Collections

Historical MCZ Collection Yields Evolutionary Clues

Historical specimens are increasingly valuable as species face extinction. They can be used to compare modern members of a species with those hundreds of years old, revealing changes in everything from diet to environment. They are also proving to be vital when scientists cannot obtain modern tissues for research, as with the threatened tuatara.

Hannah Kim Frank

The tuatara (*Sphenodon punctatus*) is a lizard-like reptile found in New Zealand. Adult males have no penis, making it a useful species in which to study the evolution of the phallus in terrestrial vertebrates. Researchers have wondered whether the common ancestor of amniotes—reptiles, birds and mammals—had a penis, which was subsequently lost in some species, or if the penis evolved later and independently in different groups.

Because of the enormous diversity in adult anatomy, answering this question required the study of genital development in tuatara embryos, but fresh samples are very difficult to obtain for this threatened species. Researchers **Thomas Sanger**, Marissa Gredler and Martin Cohn instead turned to the MCZ's collection of Victorian-era tuatara embryos.

"This collection goes back to Charles S. Minot (1852–1914), curator of the Harvard Embryological Collection," says Curatorial Associate **José Rosado**. Arthur Dendy, an English zoologist, collected the tuatara embryos between 1896 and 1897. In 1909 he transferred his collection to Minot, who prepared the specimens. "The collection contributed significantly to the study of embryology," says Rosado, "only to be lost in obscurity for much of the 20th century, stored in various places at the Harvard Medical School. Their recent rediscovery has made this collection available to add new dimensions to our study of natural history and evolution, as exemplified by Dr. Sanger's recent work."

Sanger photographed 82 of the fragile microscope slides containing thin sections of embryos more than a century old. He and colleagues then digitally removed tissues that were deteriorating and combined the remaining data into one 3D image. The image revealed swellings consistent with the development of paired genitals in the tuatara's closest living relatives, snakes and lizards, and the beginnings of a single phallus in mammals, turtles, crocodilians and some birds.

MCZ, Harvard University

As the tuatara embryo matures, the swellings fail to develop into a penis, but their existence supports the theory that the penis evolved just once in mammals and reptiles and that some animals have lost theirs over time. The findings were published in ***Biology Letters***. The original photos and the digitally restored images used for the research are archived at the MCZ.

Innovative Storage for Bird Specimens

Jeremiah Trimble

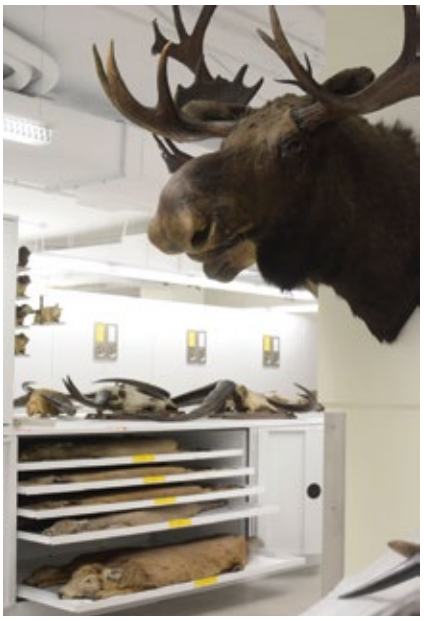
The Ornithology collection has a new display scheme designed specifically for the needs of bird specimens prepared for exhibit. These specimens are often difficult to store, but the new pegboard system allows the birds to be spaced in a way that can be customized for all the different shapes and sizes of specimens, better utilizing the space. "This system allowed us both the room and ability to store a large collection of Ornithology specimens that were rotated off exhibit during a major renovation of the HMNH public space," says Curatorial Associate **Jeremiah Trimble**. "By designing this innovative and novel storage solution, we are easily able to accommodate and properly store all of these valuable specimens."

"The specialized but simply designed equipment provides secure storage that is both flexible and efficient for these individually unique preparations of bird specimens," says **Linda S. Ford**, MCZ Director of Collections Operations.

LEED Recognition for MCZ

The MCZ's Northwest Building facilities recently received LEED platinum certification—the highest rating—from the U.S. Green Building Council. This is the ninth LEED certification and the fourth platinum certification for the building. The 50,000-square-foot build-out of state-of-the-art laboratory facilities and stable, climate-controlled storage accommodates six million zoological specimens from all or part of seven different collections: Invertebrate Paleontology, Ornithology, Vertebrate Paleontology, Malacology, Mammalogy, Entomology and Invertebrate Zoology.

Thirteen percent of the materials in the project space are made of recycled content, and regional materials make up 36 percent of the new construction materials. Energy-efficiency measures include an integrated laboratory pressurization control system and occupancy sensors to control lighting and automate temperature settings. LED lighting will use 31 percent less power, and efficient plumbing fixtures will reduce water use by 32 percent.



Melissa Aja

MCZ First Floor Renovations

An institution that opened in 1859 would naturally evolve over the years. The latest renovations to the MCZ building's first floor, completed in fall 2016, were made possible when the staff, collection and prep spaces for Vertebrate Paleontology relocated to the Northwest Building.

Photos by Melissa Aja

Two outdated, uncomfortable classrooms are now modernized and side-by-side, offering more functionality—MCZ 101 (left) and the Oceanography seminar room (right). These classrooms were updated with state-of-the art technology and mobile chairs and desks. Off a stairwell and impossible to find, the former Oceanography classroom will become a faculty office.

The Agassiz Room (left), a much-used and beloved conference space, was moved from the basement level of the OEB administration offices to a temporary home on the first floor of the MCZ. (It will move again in a later stage of renovations.) The former Agassiz Room was revamped and turned into greatly needed office space for the Harvard Museums of Science and Culture. At right is the new employee lounge.

Projects & Initiatives

Encyclopedia of Life Learning + Education Group

The Encyclopedia of Life (eol.org) is a global effort to bring together species information in a free, trusted online resource. Content on EOL is provided by hundreds of partners, including the MCZ. The EOL Learning + Education Group (education.eol.org), based at the MCZ, encourages the development of innovative and effective uses of EOL content and tools in educational settings.

Species Cards

Species Cards (eol.org/info/species_cards) are built from EOL Collections and trait data from TraitBank and other sources. Traits may include species interactions, size categories, colors of organisms, body measurements, plant growth habits, phenology data and more. Learn more about TraitBank at eol.org/info/traitbank, including the breadth of data available and how to contribute or download data. Card decks can be viewed online or PDFs can be downloaded for printing. Species Cards are being used in lessons and activities for students in elementary and middle schools (ages 7–13). eol.org/info/ed_resources

Okaloosa SCIENCE Grant

EOL is now in the third and final year of the Okaloosa SCIENCE project, supported by a Department of Defense Education Activity grant to improve STEM education through outdoor activities and community partnerships. This year, EOL L+E staff are running professional development workshops for teachers and schoolyard BioBlitzes—species inventories—to bring its biodiversity learning tools and resources into classrooms. education.eol.org/ecosystems/ecoproj.php?proj_id=4

Broader Impacts for the Kurator Project

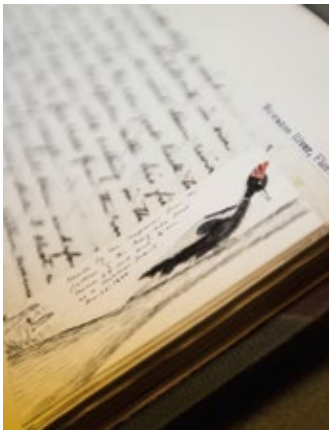
Harvard University and the University of Illinois Urbana–Champaign were awarded a National Science Foundation grant to develop software tools for natural history collection data digitization, sharing, integration and use. This grant will develop Kurator, an open-source toolkit for providing data quality information for natural history collections. EOL is collaborating with Integrated Digitized Biocollections (idigbio.org) and Advancing Integration of Museums into Undergraduate Programs (aimup.unm.edu) to develop an educational module for undergraduate students focusing on using natural history collections to answer ecological questions and to improve student data literacy.

U.S. National Parks Centennial

The EOL L+E group has been participating in the U.S. National Park Service and National Geographic Society annual BioBlitz species inventories since 2009. EOL has supported these events through the development of educational activities, EOL Collections and field guides. There were hundreds of BioBlitzes around the country in 2016 to commemorate the centennial of the U.S. National Park Service, and EOL staff participated in events at Gulf Islands National Seashore and the National Mall in Washington, D.C.

Amy Lorenz

William Brewster's Field Notes



Kris Snibbe

The digitization and transcription of ornithologist William Brewster's diaries (1851–1919), field journals, photographs and correspondence has been an ongoing project at the Ernst Mayr Library. Supported by various grants from the Institute of Museum and Library Services and the Council on Library and Information Resources, the goal of the project is to make all Brewster's notes and correspondence digitally accessible for study. Currently, the CLIR Field Notebook Project grant is supporting the digitization of 9,821 remaining items in the William Brewster collection.

Betsy Meyer, who has been scanning and transcribing Brewster's notes, began highlighting interesting tidbits from these documents in a series of Ernst Mayr Library blog posts as a way to bring the library's community into the ongoing project and showcase the value of texts where the scientific and the personal overlap. So far, the blog series has touched on a range of scenes from Brewster's life, from wild animal encounters to Boston courtrooms in early debates over wildlife protection legislation. library.mcz.harvard.edu/blog

Laura Bush 21st Century Librarian Award

The Ernst Mayr Library was awarded an IMLS grant, Foundations to Actions: Extending Innovations in Digital Libraries in Partnership with National Digital Stewardship Learners. Five residents across the United States will work on different Biodiversity Heritage Library projects. The resident based at the Ernst Mayr Library will develop a mechanism to incorporate transcription files from manuscripts into the BHL infrastructure, eventually allowing searching and indexing of handwritten documents such as field notes and correspondence.

MCZ, Ernst Mayr Library

Science without Borders Intern

Bruno Costelini joined the Ernst Mayr Library for three months to process and organize the papers of Ruth Turner, one of the foremost marine scientists of the 20th century, and delve into the Hassler Archives. He scanned 166 photographs of the Hassler expedition and organized metadata, transcribed James H. Blake's expedition journal and built a spreadsheet of his roughly 100 watercolors. He explored materials from the Hassler expedition at several libraries across Harvard and plans to write a paper about his work.

Costelini presented a poster on the Hassler Archives at the summer intern poster session and actively contributed to the library blog. library.mcz.harvard.edu/blog

Expanding Access to Biodiversity Literature

Awarded in October 2015 to the New York Botanical Garden with partners Ernst Mayr Library and Missouri Botanical Garden, the goal of this grant is to increase the availability of biodiversity literature by seeking out content providers who may need assistance in digitization or deposit and negotiating with copyright holders for more current publications. EML will also work with the Digital Public Library of America to ensure metadata is available for ingest, thus broadening the prospective audience and enhancing accessibility to the literature of biodiversity. Through this grant, the library was able to hire **Patrick Randall** to negotiate copyright agreements, provide social media outreach for the Ernst Mayr Library and respond to internal and external digitization, thus improving access to the Ernst Mayr Library collections, particularly those that are offsite or fragile.

Marine Life

On November 21, 2015, the new *Marine Life* exhibition in the Putnam Family Gallery opened at the Harvard Museum of Natural History. *Marine Life* is made possible by a generous gift from George Putnam III, AB 1973, JD 1977, MBA 1977, and Kathy Putnam.

The centerpiece of *Marine Life* is an immersive, floor-to-ceiling recreation of life in New England's coastal waters, highlighting the diversity and dynamic interplay of local marine communities. As models of glowing jellies, a giant sea turtle and other sea animals swim overhead, visitors explore new research and displays of real fishes, mollusks, crustaceans, corals and other marine organisms. These "wet" specimens—demonstrating the breadth of the collections and the science behind them—were provided by the MCZ Invertebrate Zoology, Malacology and Ichthyology collections. Bird specimen mounts were selected from the Ornithology collection.

Melissa Aja

A special interactive display introduces the world of jellyfish, and the ocean exploration theater offers a multimedia journey of discovery from the surface to the deep oceans. MCZ faculty-curators **James McCarthy** and **Gonzalo Giribet** are featured in a video about the history of oceanography at Harvard, and they are among the four Harvard faculty members that provided the foundation for the exhibition. HMSC exhibit designers, Ichthyology staff and graduate students collaborated on the digital components.

David Brown

Sea Creatures in Glass

Sea Creatures in Glass: The Blaschka Marine Animals at Harvard, by Elizabeth R. Brill and Florian Huber, was published to celebrate the restoration and permanent display of these extraordinary glass representations of marine organisms. It is the first publication featuring the MCZ's exceptional collection of models created by father and son artists Leopold and Rudolf Blaschka in the late nineteenth century.

Delicate jellyfish and anemones, octopus, squid and soft-bodied sea creatures—commissioned by universities and museums throughout the world as teaching models—are renowned for their beauty and exacting detail and are still relevant to marine study today. *Sea Creatures in Glass* features stunning photography of 60 of the most exquisite models from this superb collection.

Awards & Recognition

Bear Cieri Photography

Hopi Hoekstra

Emeritus

Edward O. Wilson received the Harper Lee Award for Southern Literature from the Alabama Literary Association. The PBS special *E. O. Wilson: Of Ants and Men* was released; it won awards in two categories at the Jackson Hole Wildlife Film Festival and has received Emmy nominations for best television program, also in two categories.

Faculty

Brian D. Farrell was awarded funding from the Harvard University Climate Change Solutions Fund.

Jenn Thomson

Mansi Srivastava

Gonzalo Giribet was awarded a 2016 John Simon Guggenheim Fellowship in the field of Organismic Biology and Ecology. Guggenheim fellows are appointed on the basis of impressive achievement in the past and exceptional promise for future accomplishment.

Hopi Hoekstra was elected to the U.S. National Academy of Sciences, in recognition of her distinguished and continuing achievements in original research.

George V. Lauder was elected a Fellow of the American Physical Society for fundamental contributions to understanding aquatic propulsion in fishes through experimental hydrodynamics.

Naomi Pierce received the E. O. Wilson Naturalist Award from the American Society of Naturalists for significant contributions to the knowledge of a particular ecosystem or group of organisms.

Mansi Srivastava was named a Searle Foundation Scholar for her potential to make significant contributions to chemical and biological research.

Staff

Penny Benson marked her 5th-year service anniversary at the MCZ.

Jessica Cundiff and **Breda Zimkus** became Co-Chairs of the Best Practices Committee for the Society for the Preservation of Natural History Collections.

Linda S. Ford became President of the Society for the Preservation of Natural History Collections.

Keleigh Quinn received a Dean's Distinction Award from the Harvard Faculty of Arts and Sciences.

Postdoctoral Researchers

Charlotte Jandér

Charlotte Jandér received a research grant from Stiftelsen Extensus, Sweden, and a travel award from the Smithsonian Tropical Research Institute.

Brent Hawkins

Graduate Students

Felix Baier was awarded a Howard Hughes Medical Institute International Research Fellowship to support three years of his PhD research.

Caitlin Baker, **Julia Cosgrove** and **Vanessa Knutson** received an NSF Graduate Research Fellowship Program award.

John H. Boyle, **Brianna McHorse**, **Zachary Morris** and **Elizabeth Sefton** were awarded the Derek Bok Certificate of Distinction in Teaching. McHorse also received a Sigma Xi Grant-in-Aid of Research and Chapman Memorial Scholarship for Locomotion Research funding. Morris also received a Wood Student Research Award from the Society of Paleontology.

Brianna McHorse

James Crall was awarded a research grant from the Winslow Foundation.

Patrick Gorring, **Alyssa Hernandez** and **Sang Il Kim** received travel grants from the David Rockefeller Center for Latin American Studies. Gorring also received a Huron Mountain Wildlife Foundation Research Grant. Kim also received a Systematics Research Fund grant from the Systematics Association and the Linnean Society of London.

Sang Il Kim

Emily Hager was awarded an American Society of Mammalogists Grant-in-Aid of research for her work on morphological and behavioral adaptation.

Talia Moore received a Robert A. Chapman Memorial Scholarship.

Shayla Salzman was a recipient of the Grady L. Webster Award, American Society of Plant Taxonomists, for the most outstanding paper published in *Systematic Botany* or *Systematic Botany Monographs* in the field of plant systematics for the years 2014 and 2015.

Brent Hawkins and Bruno de Medeiros received an NSF Doctoral Dissertation Improvement Grant. Medeiros also received a Jorge Paulo Lemann Fellowship.

Undergraduates

Andreé Franco-Vasquez and **Silvia Golumbeanu** were awarded Harvard College Program for Research in Science and Engineering fellowships.

Bruno de Medeiros

Elizabeth Benson

MCZ Grant Recipients Academic Year 2015–2016

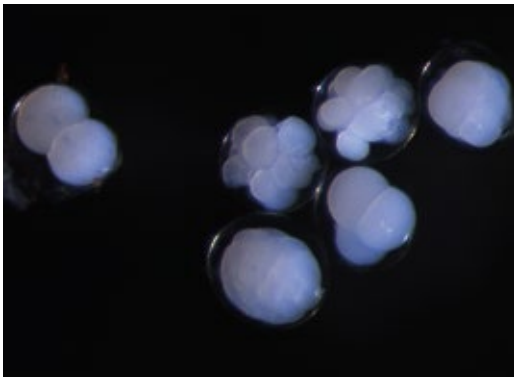
Grants in Aid of Undergraduate Research (GUR)

These grants support research by Harvard College undergraduates under faculty supervision. Priority is given to projects that utilize MCZ, Harvard University Herbaria (HUH) and Arnold Arboretum (AA) research collections, laboratories and facilities. Support for these grants comes from the MCZ's Myvanwy M. and George M. Dick Scholarship for Students, HUH and AA.

Recipient	Faculty Sponsor/ Academic Dept.	Project Title	Amount
Madeleine V. Ankhelyi	George Lauder/ Organismic and Evolutionary Biology	Morphological differences in placoid scales on different species and body regions of sharks	$2,430
Lorena M. Benitez	Stephanie Pierce/ Organismic and Evolutionary Biology	Vertebral morphology of a basal pelycosaur and its implications for locomotor evolution in synapsids	$2,500
Elizabeth L. Benson	Naomi Pierce/ Organismic and Evolutionary Biology	Testing convergent interactions and community succession with Australian carnivorous pitcher plants	$2,500
Christopher H. Chen	Donald Pfister/ Organismic and Evolutionary Biology	Evolution of hyperparasitism in a system of Laboulbeniales, bat flies and bats	$1,800
Eamon C. Corbett	Scott Edwards/ Organismic and Evolutionary Biology	Thesis research on biogeography and genetics of birds of northeastern Brazil in Recife, Pernambuco	$970
Andree M. Franco Vasquez	Mansi Srivastava/ Organismic and Evolutionary Biology	Gene expression profile of stem cells in acoels characterized by *in situ* hybridization	$2,500
Kaitlyn A. Gibson	Stephanie Pierce/ Organismic and Evolutionary Biology	Digital vertebral modeling of *Chiniquodon* and *Ctenorhachis*	$1,770
Silvia Golumbeanu	Mansi Srivastava/ Organismic and Evolutionary Biology	*Piwi-1* presence and cell pluripotency in early embryonic development of *Hofstenia miamia*	$2,500
Ann H. Opel	Colleen Cavanaugh/ Organismic and Evolutionary Biology	The effect of coral outplant sites on local fish communities	$900
Christian A. Perez	Jonathan Losos/ Organismic and Evolutionary Biology	Habitat partitioning and locomotor patterns in three species of Costa Rican anoles	$2,500

Emily Venable

Elizabeth Benson



Silvia Golumbeanu

Katrina Jones

Lorena Benitez

Polat Dyar

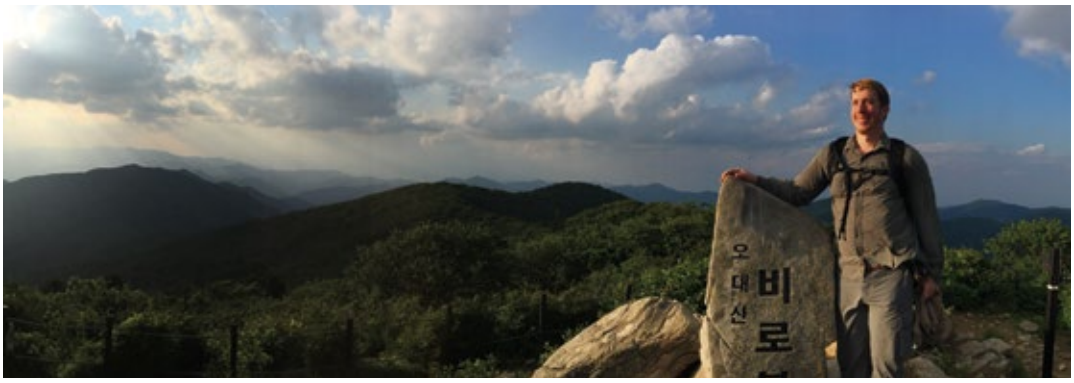
Annie Opel

Recipient	Faculty Sponsor/ Academic Dept.	Project Title	Amount
Kristin M. Tsuo	Terence Capellini/ Human Evolutionary Biology	Genome-wide studies of genetic variants affecting body proportion and height	$2,500
Emily M. Venable	Richard Wrangham/ Human Evolutionary Biology	Investigation of the observed sexual dimorphism in chimpanzee wood eating	$2,000
Anthony W. Wohns	Terence Capellini/ Human Evolutionary Biology	Why the long tendon? The role of muscle force on gene expression and morphology in the developing Achilles tendon	$2,500
		Total Awards	**$27,370**

Robert G. Goelet Research Awards

Goelet Awards support MCZ graduate student research projects. These grants are made possible through a gift from Mr. Robert G. Goelet.

Recipient	MCZ Department	Project Title	Amount
Mara Laslo	Herpetology	Thyroid hormone-independent limb development in a direct-developing frog, *Eleutherodactylus coqui*	$1,407
Patrick Gorring	Entomology	Determining host plant influence on speciation in sky island beetles	$2,500
		Total Awards	**$3,907**



Patrick Gorring

Andres Vega

Christian Perez

Mara Laslo

Patrick Gorring

Lilian Macedo

Ernst Mayr Travel Grants in Animal Systematics

Ernst Mayr Grants support travel for research in animal systematics and are open to the scientific community worldwide. The principal objective of these grants is to stimulate taxonomic work on neglected taxa and/or poorly described species. Ernst Mayr Grants typically facilitate visits to institutional collections, with preference given to research that uses MCZ's collections. These grants are made possible by a gift from Professor and former MCZ Director Ernst Mayr.

Recipient	Institutional Affiliation	Project Title	Amount
Consuelo N. Alarcon Rodriguez	San Antonio Abad National University of Cusco	An integrative taxonomic revision of genus *Oxyrhopus*	$863
Michael G. Branstetter	University of Utah	The leaf litter ants of Colombia	$1,420
David A. Bullis	State University of New York	Taxonomy and shell morphology of a nearly extinct Pacific endemic land snail group: The endodontoids of Drs. Yoshio Kondo (BPBM: 1934–1980) and Alan Solem (FMNH: 1957–1990)	$1,424
Sarah Z. Gibson	University of Kansas	Examining the evolutionary relationships of fishes of the order Redfieldiiformes (Actinopterygii: Palaeoniscimorpha) from the Early Mesozoic	$1,500
María Rebecca Granja-Fernández	Universidad Autónoma Metropolitana	Taxonomy of the Ophiuroidea (Echinodermata) from the tropical eastern Pacific	$1,500
Maike Hernández Quinta	Institute of Ecology and Systematics, Havana	Review family Cepolidae of the Caribbean, with emphasis in the *Jeanneretia* genus at MCZ	$1,500
Paul J. Johnson	South Dakota State University	Otto Schwarz primary types of Andean and Amazonian Elateridae	$1,420
Gustavo S. Libardi	Instituto de Diversidad y Evolución Austral, CONICET	Taxonomic revision of the genus *Necromys* Ameghino, 1889 (Rodentia: Cricetidae)	$1,500
Lilian Cristina Macedo	Federal University of Para	Revision of the *Physaloptera* spp. Rudolphi, 1819 from South American reptiles	$1,500
Shirley Daniella Martínez-Torres	Universidad Nacional de Colombia	Taxonomic review and geographical distribution of the neotropical millipede genus *Psammodesmus* Cook, 1896 (Diplopoda: Polydesmida: Platyrhacidae)	$1,500
Robert K. McAfee	Ohio Northern University	Expanded systematics of the Caribbean fossil sloths	$1,260

Renata Stopiglia

Italo Salvatore de Castro Pecci-Maddalena

Robert McAfee

Maike Hernández

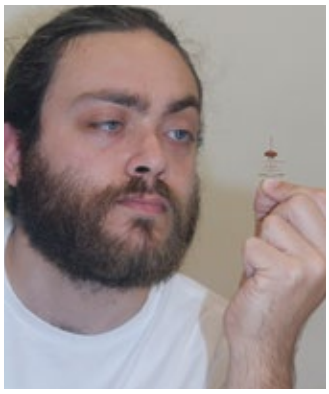
Oleksander Varga

Yongying Ruan (2)

Recipient	Institutional Affiliation	Project Title	Amount
Katherine Nazario	University of Connecticut	Revision of the cicada genus *Tettigades* (Auchenorrhyncha, Cicadidae)	$1,500
Brittany E. Owens	Louisiana State University	Monography of the New Zealand Pselaphini (Coleoptera: Staphylinidae: Pselaphinae)	$1,500
Italo Salvatore de Castro Pecci-Maddalena	Federal University of Viçosa	Taxonomic revision of *Mycotretus* Lacordaire (Coleoptera: Erotylidae: Tritomini): The type specimens from MNHN	$1,500
Abel Perez-Gonzalez	Museo Argentino de Ciencias Naturales, CONICET	Taxonomy and fine morphological characterization of poorly known key species of Malagasy harvestmen (Opiliones: Laniatores)	$1,500
Gareth S. Powell	Purdue University	Revision of Nearctic *Carpophilus* Stephens	$1,080
Matthew M. Prebus	University of California, Davis	The ant genus *Temnothorax* Mayr 1861: Redefinition, subgeneric classification and Hispañola species revision	$1,330
Yongying Ruan	Chinese Academy of Sciences	Revision of Oriental *Chaetocnema* (Coleoptera, Chrysomelidae) species	$1,500
David Salazar-Valenzuela	Ohio State University	Clarifying the systematics of the "ultimate pitvipers" (*Bothrops asper* species complex) a medically important group of Neotropical snakes	$1,500
Renata Stopiglia	Universidad de São Paulo	Taxonomic revision of the species of the subtribe Synallaxina (Synallaxini, Furnariidae, Passeriformes, Aves)	$1,500
Oleksandr Varga	Schmalhausen Institute of Zoology	An investigation of Ichneumonidae types (Insecta, Hymenoptera, Ichneumonidae) deposited in the Bavarian State Collection of Zoology	$1,100
Hessarghatta Murthy Yeshwanth	University of Agricultural Sciences, Bangalore	Examination and study of Miridae types at the Natural History Museum	$1,500
		Total Awards	**$30,897**

María Rebecca Granja-Fernández

María Rebecca Granja-Fernández



Camila Folly Baptista

Italo Salvatore de Castro Pecci-Maddalena

Renata Stopiglia

Abel Perez-Gonzalez

Daniela Martinez Torres

Claire Dufour

Putnam Expedition Grants

Putnam Expedition Grants are intended to support MCZ faculty-curators, postdoctoral fellows and graduate students in collecting specimens and data relating to the study of comparative zoology. Priority is given to projects that collect living specimens in regions where habitats are threatened or fossil specimens in regions most likely to hold important clues for unraveling evolutionary strategies. These grants are made possible by a gift from Mr. George Putnam, Jr., AB 1949 and MBA 1951, and Mrs. Nancy Putnam.

Recipient	MCZ Department	Project Title	Amount
Nicole L. Bedford	Mammalogy	Quantifying burrow usage patterns in a near-threatened beach mouse species (*Peromyscus polionotus leucocephalus*)	$7,875
Ligia R. Benavides Silva	Invertebrate Zoology	Discovering the soil arthropods of the "path to the panther"	$3,010
Leonora S. Bittleston	Entomology	The third convergent host: Insect communities from *Cephalotus follicularis* in Australia	$8,060
Tauana Cunha	Invertebrate Zoology	Resolving the deep relationships of the Gastropoda	$8,475
Claire Marie-Soleil Dufour	Herpetology	Coexistence mechanisms between the native species *Anolis oculatus* and a new intruder *Anolis cristatellus* in Dominica	$9,432
Rosa M. Fernández	Invertebrate Zoology	Exploring terra incognita: Soil fauna of New Caledonia	$12,876
Kadeem J. Gilbert	Entomology	Phylogeography of *Nepenthes*-associated dipterans of the Philippines	$9,198
Emily Hager	Mammalogy	Behavioral and morphological change across a transect in habitat type	$11,348
Oriol Lapiedra Gonzalez	Herpetology	Does individual variation in behavior determine natural selection in new environments?	$10,154
Gerard Talavera	Entomology	Phylogeny of the most cosmopolitan animal migrator: the butterfly *Vanessa cardui*	$8,000
		Total Awards	**$88,428**

Tauana Cunha

Ligia R. Benavides Silva

Tauana Cunha

Vanessa Knutson

Tauana Cunha

Nate Dappen / Days Edge Productions

Oriol Lapiedra Gonzalez

MCZ Publications in Calendar Year 2015

• **Andrade SCS, Novo M, Kawauchi GY**, Worsaae K, Pleijel F, **Giribet G**, Rouse GW (2015) Articulating "archiannelids": Phylogenomics and annelid relationships, with emphasis on meiofaunal taxa. *Mol Biol Evol* 32:2860-2875

• André T, Specht C, **Salzman S**, Palma-Silva C, Wendt T (2015) Evolution of species diversity in the genus *Chamaecostus* (Costaceae): Molecular phylogenetics and morphometric approaches. *Phytotaxa* 204:265-276

• Badenhorst D, Hillier LW, Literman R, Montiel EE, Radhakrishnan S, Shen Y, Minx P, **Janes DE**, Warren WC, **Edwards SV**, Valenzuela N (2015) Physical mapping and refinement of the painted turtle genome (*Chrysemys picta*) inform amniote genome evolution and challenge turtle-bird chromosomal conservation. *Genome Biol Evol* 7:2038-2050

• Balenger SL, Bonneaud C, Sefick SA, **Edwards SV**, Hill, GE (2015) Plumage color and pathogen-induced gene expression in a wild bird. *Behav Ecol* 26:1100-1110

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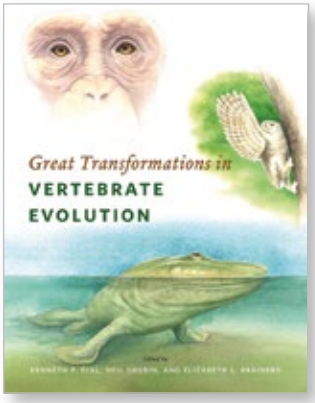
Research by **Glenna Clifton**, **Andrew Biewener** and colleague, "Western and Clark's grebes use novel strategies for running on water," was featured on the cover.



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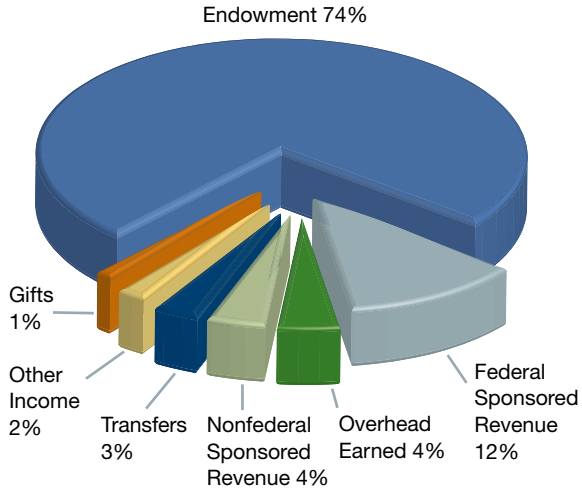
Financial Data

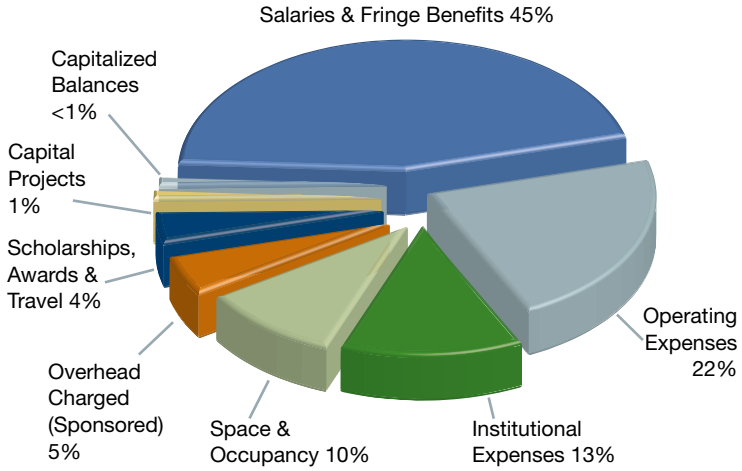
These charts describe the income and expenses of the Museum of Comparative Zoology in fiscal year 2016.

Endowment income funds much of the Museum's activities, including acquisition and maintenance of collections, faculty and staff salaries, capital projects, facilities renovation and maintenance. Included in **Endowment** income is the annual distribution, revenue generated from assets purchased through endowments and endowed funds decapitalized per donor request. **Transfers** include Harvard University-funded faculty research, financial support for the Ernst Mayr Library and other Harvard-funded projects. **Other Income** comprises miscellaneous income from publication subscriptions, royalties, sales and fees, and cost recovery from other MCZ-sponsored activities. **Overhead** is funding paid from MCZ-based sponsored projects to cover facilities and administrative costs for those projects. It is shown as both income (**Overhead Earned**) and expenses (**Overhead Charged**). **Capital Projects** includes deployment of collections to the newly constructed space in the Northwest Building. Building expenses such as maintenance, facility improvements and utilities are captured in the **Space & Occupancy** category. **Operating Expenses** consist of equipment purchases, supplies, and consultant and conference fees, as well as annual subventions to the Department of Organismic and Evolutionary Biology (OEB) for administrative services. Support for MCZ-affiliated graduate students in OEB is included in **Scholarships, Awards & Travel**. **Institutional Expenses** are support for other University activities outside the MCZ, including FAS and University initiatives and general operating support to the Harvard Museum of Natural History.

Income



Expenses & Non-Operating Funds



Income

Endowment	$15,448,974
Federal Sponsored Revenue	$2,606,436
Overhead Earned	$912,655
Nonfederal Sponsored Revenue	$830,192
Transfers	$582,441
Other Income	$307,645
Gifts	$265,646
Total	**$20,953,989**

Expenses

Salaries & Fringe Benefits	$9,082,957
Operating Expenses*	$4,497,959
Institutional Expenses*	$2,732,858
Space & Occupancy	$2,130,409
Overhead Charged (Sponsored)	$912,636
Scholarships, Awards & Travel	$770,104
Capital Projects	$158,494
Capitalized Balances	$21,252
Total	**$20,306,669**

** These two expense categories are calculated differently than in past years.*

Faculty-Curators

Andrew A. Biewener
Charles P. Lyman Professor of Biology; Director, Concord Field Station

Scott V. Edwards
Professor of Organismic & Evolutionary Biology; Alexander Agassiz Professor of Zoology; Curator of Ornithology

Brian D. Farrell
Professor of Biology; Curator of Entomology; Director, David Rockefeller Center for Latin American Studies

Gonzalo Giribet
Professor of Organismic & Evolutionary Biology; Alexander Agassiz Professor of Zoology; Curator of Invertebrate Zoology

James Hanken
Professor of Biology; Alexander Agassiz Professor of Zoology; Curator of Herpetology; Director, MCZ

Hopi E. Hoekstra
Professor of Organismic & Evolutionary Biology; Professor of Molecular & Cellular Biology; Alexander Agassiz Professor of Zoology; Curator of Mammalogy; Howard Hughes Medical Institute Investigator; Harvard College Professor

George V. Lauder
Professor of Biology; Henry Bryant Bigelow Professor of Ichthyology; Curator of Ichthyology

Jonathan B. Losos
Professor of Organismic & Evolutionary Biology; Monique & Philip Lehner Professor for the Study of Latin America; Curator of Herpetology

James J. McCarthy
Professor of Biological Oceanography; Alexander Agassiz Professor of Biological Oceanography; Acting Curator of Malacology

Naomi E. Pierce
Sidney A. & John H. Hessel Professor of Biology; Curator of Lepidoptera

Stephanie E. Pierce
Assistant Professor of Organismic & Evolutionary Biology; Curator of Vertebrate Paleontology

Mansi Srivastava
Assistant Professor of Organismic & Evolutionary Biology; Curator of Invertebrate Zoology

Robert M. Woollacott
Professor of Biology; Curator of Marine Invertebrates

Emeritus Faculty

A.W. "Fuzz" Crompton
Faculty-Curator, Emeritus; Fisher Professor of Natural History, Emeritus

Richard C. Lewontin
Professor of Biology, Emeritus; Alexander Agassiz Professor of Zoology, Emeritus

Edward O. Wilson
Honorary Curator in Entomology; Pellegrino University Professor, Emeritus

Postdoctoral Fellows, Research Associates & Visiting Scholars

Allison Arnold-Rife
Concord Field Station, Biewener Lab

Ligia Benavides Silva
Invertebrate Zoology, Giribet Lab

Andrés Bendesky
Mammalogy, Hoekstra Lab

Partha Bhagavatula
Concord Field Station, Biewener Lab

Alison Cloutier
Ornithology, Edwards Lab

David Combosch
Invertebrate Zoology, Giribet Lab

Valentina Di Santo
Ichthyology, Lauder Lab

Colin Donihue
Herpetology, Losos Lab

Claire Dufour
Herpetology, Losos Lab

Pierre-Henri Fabre
Herpetology, Losos Lab

Stacy Farina
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Rosa Fernández García
Invertebrate Zoology, Giribet Lab

Heidi Fisher
Mammalogy, Hoekstra Lab

Hunter Fraser
Mammalogy, Hoekstra Lab

Anthony Geneva
Herpetology, Losos Lab

Andrew Gehrke
Invertebrate Zoology, Srivastava Lab

Alexis Harrison
Herpetology, Losos Lab

Caroline Hu
Mammalogy, Hoekstra Lab

Charlotte Jandér
Entomology, N. Pierce Lab

Katrina Jones
Vertebrate Paleontology, S. Pierce Lab

Robert Kambic
Vertebrate Paleontology, S. Pierce Lab

Betul Kacar
Ornithology, Edwards Lab

Albert Kao
Entomology, N. Pierce Lab

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Ichthyology, Lauder Lab

Nicolai Konow
Concord Field Station, Biewener Lab

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Invertebrate Zoology, Giribet Lab

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Herpetology, Losos Lab

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Global Ant Project, Wilson Lab

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Herpetology, Losos Lab

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Ornithology, Edwards Lab

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Ornithology, Edwards Lab

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Ornithology, Edwards Lab

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Concord Field Station, Biewener Lab

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Entomology, N. Pierce Lab

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Maude Baldwin
Ornithology, Edwards Lab

Nicole Bedford
Mammalogy, Hoekstra Lab

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Entomology, N. Pierce Lab

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Invertebrate Zoology, Giribet Lab

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Entomology, N. Pierce Lab

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Concord Field Station, Biewener Lab

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Invertebrate Zoology, Giribet Lab

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Concord Field Station, Biewener Lab

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Marine Invertebrates, Woollacott Lab

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Ichthyology, Lauder Lab

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Associates

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Associate of Entomology
Harvard University

Brian S. Arbogast
Associate of Mammalogy
University of North Carolina Wilmington

Bruce Archibald
Associate of Entomology
Simon Fraser University

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Aaron Bauer
Associate of Herpetology
Villanova University

Andrew Berry
Associate of Population Genetics
Harvard University

Elizabeth Brainerd
Associate of Ichthyology
Brown University

Jae Choe
Associate of Entomology
Ewha Womans University

Janet Collett
Associate of Population Genetics
University of Sussex

Bruce Collette
Associate of Ichthyology
National Marine Fisheries Service

David Bruce Conn
Associate of Invertebrate Zoology
Berry College

James Costa
Associate of Entomology
Western Carolina University

Catherine Craig
Associate of Invertebrate Zoology
Conservation Through Poverty Alleviation, International

Harlan Dean
Associate of Invertebrate Zoology
Harvard University

Lloyd Demetrius
Associate of Population Genetics
Harvard University

Philip DeVries
Associate of Entomology
University of New Orleans

Gregory D. Edgecombe
Associate of Invertebrate Zoology
Natural History Museum, England

Ben Evans
Associate of Herpetology
McMaster University

Brooke E. Flammang
Associate of Ichthyology
New Jersey Institute of Technology

Kelvin A. Guerrero
Associate of Entomology
Systematic Entomologist/Environmental Consultant

Michael Hadfield
Associate of Marine Biology
University of Hawaii

Berthold Hölldobler
Associate of Entomology
Arizona State University

Gustavo Hormiga
Associate of Invertebrate Zoology
The George Washington University

Helen F. James
Associate of Ornithology
National Museum of Natural History, Smithsonian

Alan Kabat
Associate of Malacology
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Leslie S. Kaufman
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Boston University

Gisele Y. Kawauchi
Associate of Invertebrate Zoology
University of São Paulo

Timothy Laman
Associate of Ornithology
National Geographic

Ruth Hortencia Bastardo Landrau
Associate of Entomology
Universidad Autónoma de Santo Domingo

Phillip Lobel
Associate of Ichthyology
Boston University

David Lohman
Associate of Entomology
The City College of New York

Vladimir A. Lukhtanov
Associate of Entomology
Russian Academy of Sciences

James Mallet
Associate of Population Genetics
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Russell Mittermeier
Associate of Herpetology
Conservation International

Piotr Naskrecki
Associate of Entomology
Conservation International

Diane B. Paul
Associate of Population Genetics
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David L. Pawson
Associate of Marine Biology
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Stewart Peck
Associate of Entomology
Carleton University

Paulo Petry
Associate of Ichthyology
The Nature Conservancy

Steve Poe
Associate of Herpetology
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Michael Rex
Associate of Malacology
University of Massachusetts, Boston

Jessica Rykken
Associate of Entomology
Harvard University

Çağan H. Şekercioğlu
Associate of Ornithology
University of Utah

Andrea Sequeira
Associate of Entomology
Wellesley College

Steven O. Shattuck
Associate of Entomology
Commonwealth Scientific and Industrial Research Organization (CSIRO)

Scott R. Shaw
Associate of Entomology
University of Wyoming

Stephen Tilley
Associate of Herpetology
Smith College

James Traniello
Associate of Entomology
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David Wagner
Associate of Entomology
University of Connecticut

David Wake
Associate of Herpetology
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Marvalee Wake
Associate of Herpetology
University of California, Berkeley

Philip S. Ward
Associate of Entomology
University of California, Davis

Jacqueline Webb
Associate of Ichthyology
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R. Haven Wiley
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Cheryl Wilga
Associate of Ichthyology
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Mingyuan Song
Ernst Mayr Library

Ashley Steinkraus
Encyclopedia of Life

Michael Vitale
Encyclopedia of Life

Yuchen Xiao
Marine Invertebrates

Encyclopedia of Life, Learning + Education Group

Tracy Barbaro
Project Coordinator

Jeffrey T. Holmes
Digital Learning Editor

Amy Lorenz
Project Coordinator

Marie M. Studer
Learning + Education Director

Administration for the Department of Organismic & Evolutionary Biology

Krista Carmichael
Senior Research Administrator

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Peg Richard
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Damari Rosado
Associate Director of Administration

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Acknowledgements

This annual report was produced by the Office of the Director of the Museum of Comparative Zoology.

Editors

James Hanken, Director
Melissa Aja, Museum Projects Coordinator

Copy, Design & Production

Cyndi Wood
Creative Project Management, Inc.
creativeprojectmgmt.com

HARVARD
MUSEUM OF COMPARATIVE ZOOLOGY

26 Oxford Street
Cambridge, MA 02138
617.495.2460
mcz.harvard.edu