Burke MUSEUM
UNIVERSITY of WASHINGTON

Research Newsletter

DISCOVER

VOLUME NO. 1
IN THIS JULY 2014 ISSUE

NATIVE AMERICAN ANTHROPOLOGY

Restoring through Rebuilding

Angyaat were an essential part of the Sugpiat peoples of Southern Alaska's livelihood and culture for thousands of years. An open boat used for transportation, hunting, trading, warring and more, Angyaat (singular Angyaaq) were a symbol of prosperity and wealth. Remnants of these boats are present in archaeological sites; yet, by the 1820s, roughly twenty years after contact, Russian promoshelnikii had either taken or destroyed all Angyaat in an effort to take away the Native peoples' ability to move, gather in large numbers, and display their wealth and power. Due to this destruction, very little is known about a type of boat once common on Kodiak Island.

Less than a dozen of these models are known to exist today—one of them is in the Burke's ethnology collection

Curator of Native American Anthropology Dr. Sven Haakanson, along with community members from the village of Akhiok on Kodiak Island, Alaska, are reviving Angyaaq boat-making and restoring this knowledge to the Sugpiat people of Kodiak. The revival of these boats is made possible by model Angyaat, which are believed to have been used for ceremonies and passing down traditional knowledge. Less than a dozen of these models are known to exist today—one of them is in the Burke's ethnology collection. By studying this model Angyaaq along with models from other museums, Dr. Haakanson and other researchers can determine how to rebuild the Angyaat. Using the models, they can start to learn which parts of a tree were used to construct different parts of the boat, as well as engineering techniques.

Over the summer, Dr. Haakanson will travel to Kodiak Island to work with Tribal members on the construction of several model Angyaat, with the goal of training students how to build a full-size, working boat in the future. Practicing this reconstruction with community members is helping share Sugpiat heritage and traditions, restoring knowledge that's been lost, and providing a research model for others around the world to emulate.

Top photo: This model Angyaaq from the Burke's collection (cat. no. 873) is informing Dr. Haakanson's work and contributing to what may be the first full-sized working boat in almost 200 years.

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VOLUME NO. 1 **JULY 2014 ISSUE**
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PACIFIC & ASIAN ETHNOLOGY

AS PART OF THEIR INDEPENDENT study examining indigenous knowledge in Oceania, students worked with Noel Quitugua, a former curator from Saipan, to learn about and make pump drills. The drills were used to make holes in shells (for necklaces) and in sails (for rigging). By making the drills themselves, the students gained an appreciation for the skills of their ancestors, and also had a chance to learn with their hands—bringing new kinds of learning to their education.

THIS SUMMER, HOLLY BARKER and 14 student-athletes are studying colonialism in Tahiti, a place that is still a part of colonized French Polynesia. The 10-day trip allows the students to maintain their commitment to sports while having transformative learning experiences. They're staying with a Tahitian family to see how colonialism impacts the lives of Tahitians.

Traditional Knowledge, Modern Applications

Recent studies show that women and minorities have less access to research opportunities and mentorship from professors as undergraduates, and this lack of access significantly impacts their ability to pursue certain career paths and graduate school. Dr. Holly Barker, who joined the Burke Museum as the curator of Pacific and Asian ethnology in the fall of 2013, aims to help break down barriers to research, especially for students of Pacific Islander heritage. Dr. Barker has already held several research courses at the Burke, creating a safe space for students to explore cultural practices and share them with others.

One of these courses consisted of eight University of Washington undergraduate students that met weekly for an independent study course focused on Micronesia. Independent study courses are often individual, but community is central to Pacific Islanders and creates a more comfortable learning environment. In Dr. Barker's class, the students took the lead in determining what they wanted to read, discuss, and learn as a group. The goals of the course were to increase the students' understanding about the history, traditions, and cultures of Micronesia, help the students conduct and present research, and prepare the students for graduate school and professional employment.

> *"It's not about going back, but figuring out how to incorporate our culture into our daily lives."* —Kwani Li-Chin, UW STUDENT

Hands-on, active learning is an important way of passing on knowledge in Oceania cultures, and the students studied objects made by their ancestors from the Burke's collection. They also read journal articles, conducted interviews with community members, and had Skype conversations with Micronesian scholars outside Seattle. In the spring of 2014, the Micronesian students participated in the UW's Undergraduate Research Symposium, where they presented a session titled "Decolonizing Micronesia." Topics included migration, healthcare, militarization, reconnecting people to the sea through fishing, and encouraging artistic expression in youth. During the research process, Dr. Barker and the Burke created a safe space to explore issues related to Micronesian colonialism, including the anger that emerges about its violence, as well as opportunities for creativity and revitalization.

"Decolonizing Micronesia" was the first session at the UW's undergraduate research symposium to feature the work of researchers of Pacific Island heritage, and focus on Pacific Islander research practices.

Unraveling Misattributions: The Work of Charles Edenshaw

The history of attribution of works of art to Charles Edenshaw, a 19th century Haida artist, reveals the dangers of speculation. Edenshaw and his contemporaries didn't sign their work; in the 19th century for the Haida, the patron who commissioned pieces that displayed inherited crests and proclaimed the owner's status was more important than the person who carved them. Nevertheless, accomplished artists were high-ranking and well known, and noble patrons sought to commission the best artists to enhance their own status. When art began to be made for sale to outsiders, very few collectors recorded the names of the makers. Some of the scholarship that attempted to identify Edenshaw's body of work may have appeared to be well-founded when written, but was later unraveled by new evidence.

In 2010, Dr. Robin K. Wright, Burke curator of Native American art, accepted an invitation to co-curate an exhibition on Charles Edenshaw for the Vancouver Art Gallery. Working with the Gallery's chief curator, Daina Augaitis, and Haida advisors and Edenshaw descendants Jim Hart and Robert Davidson, Dr. Wright produced a major exhibition and book on this important Haida artist. The exhibit, which opened in October 2013, received the Canadian Museums Association's Award for Outstanding Achievement in Research, and the exhibition catalog was among the finalists for the B.C. Book Award.

There are several reasons for the focus on identifying Edenshaw's work over the past century. The artist's family is invested in his legacy, museum curators wish to document their collections, collectors and dealers want to own and sell the very best. While Dr. Wright's past research has primarily focused on trying to correct misattributions, her work on the exhibit convinced Dr. Wright that Edenshaw's artistry deserves the high praise it has received. Expanding on the groundbreaking work of Bill Holm, who attributed more than 275 objects to Edenshaw, Dr. Wright attributed 201 additional works to the artist, more than any other 19th century Northwest Coast artist. At the same time, many objects originally believed to have been carved by Edenshaw have now been attributed to other artists. Determining what wasn't made by Charles Edenshaw requires an understanding of what he did make; developing this understanding can reveal more about the many other excellent artists who were working in the late 19th and early 20th centuries.

Top photo: Noted 19th century Haida carver Charles Edenshaw. *Inset:* The bear figure on the lid of the chest was collected by Sydney and Anne Gerber, and is now part of the Burke's ethnology collection (cat. no. 25.0/277).
TOP PHOTO ca. 1890, CANADIAN MUSEUM OF HISTORY, 88926.

NATIVE AMERICAN ART

RECREATING THE MISSING ARGILLITE CHEST PANEL
The chest in this famous photograph of Charles Edenshaw (left) was exhibited at the Alaska Yukon Pacific Exposition in Seattle in 1909. After the fair, the chest was dismantled, and the lid, its two sides, and back went to the Smithsonian's National Museum of Natural History, while the bear figure on the lid came to the Burke Museum. However, the chest's front panel went missing, and hasn't been found to this day.

In 2012, Christian White, Charles Edenshaw's great-great-grandson, received a visiting researcher grant from the Burke's Bill Holm Center. During his visit, White was inspired to recreate the missing chest panel. Thanks to several generous donors, it is now a part of the Burke Museum's collection (cat. no. 2014-15/1), and will be displayed this fall as part of *Here & Now*, an upcoming exhibit celebrating the Bill Holm Center's 10th anniversary and contemporary Northwest Native art.

Burke Museum University of Washington
VOLUME NO. 1 JULY 2014 ISSUE
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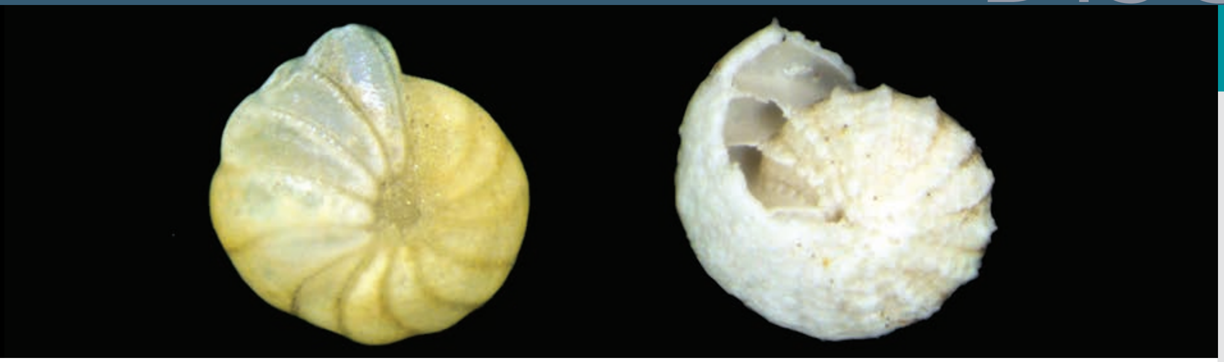


ICHTHYOLOGY

TED PIETSCH DISCOVERED A new species of anglerfish of the genus *Lasiognathus* as part of his work assessing deep-sea fish populations of the North Atlantic Ocean. This species, AKA "Doublehooked Snaggletooth Seadevil," has a unique set of bony hooks at the end of its fishing apparatus that prevent prey from biting off or damaging this critical part of its anatomy. The only known specimen of this previously unknown species is now part of the Burke Museum's fish collection.

UW GRADUATE STUDENT ALICIA Godersky is examining the Burke Museum's enormous Puget Sound larval fish collection as part of her Master's thesis. This is the first in-depth study on the distribution and seasonal abundance of Puget Sound larvae, and can help provide critical insight into early fish life in our local waters.

All the Fish in the (Salish) Sea

Fishes are a vital part of the Northwest's economy, marine environment, and regional identity; but do we even know our own fishes? The last compilation of Salish Sea fishes—nothing more than a list of species, without illustrations—was published more than three decades ago. Dr. Ted Pietsch, Burke curator of fishes, is working on the first-ever book about local marine fishes, *The Fishes of the Salish Sea*. The book is part of current efforts to protect and restore the Salish Sea, an inland waterway shared by Washington and British Columbia, which includes Puget Sound.

Over the past 30 years, the number of known fish species has increased significantly, but few people are aware of what life is like in our local waters. While working on the book, Dr. Pietsch and James Wilder Orr are referencing specimens from the Burke's fish collection. Through this project, they have discovered an additional 35 species of fishes, increasing the number of known Salish Sea species by almost 14%. In addition to cataloging new species, the book will be the first resource that covers the anatomy, identification, and taxonomy of these fishes through scientifically accurate and beautiful color illustrations. It will also highlight the geology, oceanography, and historical biogeography of the region.

> *"If we don't know what's there, we won't know what to save."*

This book will be an important community resource on the biodiversity of Puget Sound and the greater Salish Sea. On a weekly basis, the Burke's fish collection receives inquiries from members of the public who catch a fish and don't know what it is. *Fishes of the Salish Sea* will not only help to identify fishes, but can be used on fishing boats, by environmental consultants, fishery biologists, teachers, and others. It will serve as a foundation for determining the occurrence of new species and the disappearance of others, enabling the selection of species as indicators of ecosystem health, and providing a basis for identifying the mechanisms responsible for marine animal declines.

"We're very concerned about the conservation of the Puget Sound." Dr. Pietsch said. "If we don't know what's there, we won't know what to save."

The Fluffy Sculpin (*Oligocottus snyderi*) (top) and Tiger Rockfish (*Sebastes nigrocinctus*) (inset) are two of 253 known species of fishes in the Salish Sea. ILLUSTRATIONS BY JOSEPH R. TOMELLERI.

Unlocking the Mysteries of Bellingham Bay

There are wonders large and small in Puget Sound, but some of the most beautiful and useful can only be seen with a microscope. These are foraminifera—single-celled, marine organisms that live at the sediment-water interface and produce shells of calcium carbonate (calcareous), or tiny grains of sediment stuck together (agglutinate). The shells readily preserve in the sediment and document the environments in which they lived. Some species of foraminifera (forams) are highly sensitive to environmental stress, and disappear rapidly when trouble arrives. Some are extremely tolerant, thriving where others do not and acting as opportunistic colonizers of places such as sewage or industrial waste outfalls.

Curator of Invertebrate Paleontology Dr. Liz Nesbitt and Postdoctoral Fellow Dr. Ruth Martin, along with six UW undergraduate students, are utilizing foraminifera in a detailed study of the health of the ecosystem at the bottom of Bellingham Bay. This bay is of particular interest to Dr. Nesbitt's team, for it has been home to industry, particularly logging and pulp/paper mills, for 150 years. Agriculture and burgeoning residential development add to the stresses on Bellingham Bay.

> *Agriculture and burgeoning residential development add to the stresses on Bellingham Bay.*

Mitigation efforts have been ongoing since the mid-1980s, and a report testing chemical parameters from 2010 indicated the Bay fell within established limits for pollution. However, when Dr. Nesbitt's team analyzed 82 samples collected from 1987–2010, the results were not encouraging. The team discovered that diversity and density of foraminifera has declined rapidly since 1997. Many sites are now dominated by a particularly pollution-tolerant agglutinate species. This decline has also been recorded in the macro-invertebrate studies by State biologists. Surprisingly, statistical analyses revealed no correlation between foraminifera and individual pollutants (such as mercury) or classes of pollutants, suggesting an alternative environmental factor is causing the declines.

A key to unlocking the mystery of the Bay's health may be the occurrence of many foraminifera shells that have been partially dissolved, indicating high acidity in the water. In addition, most of the dominant species found in Bellingham Bay are tolerant of low oxygen conditions. Both low oxygen and high acidity can result from the decomposition of organic matter (such as fertilizers), which is prevalent in Bellingham Bay. While the mystery is unsolved, the Burke Puget Sound Foram Project is hot on the trail.

Top photo: Forams from Bellingham Bay. The opaque white specimen (right) is a deteriorated calcareous foram, compared to its healthy counterpart on the left.

INVERTEBRATE PALEONTOLOGY

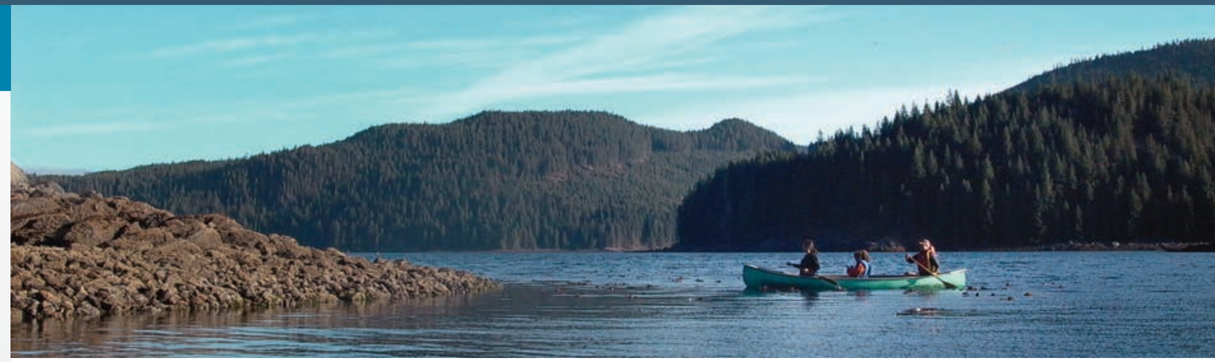
THE BURKE'S MARINE micropaleontology collection doubled in size with the transfer of the fossil foraminifera collection from the Washington State Division of Natural Resources. This remarkable collection of more than one million specimens is the only collection in the world of forams from Western Washington and Oregon, and came entirely from the work of Weldon W. Rau over his 50 year tenure as the State paleontologist. These forams were essential in dating rock formations in the region.

SIX UNDERGRADUATE STUDENTS from the UW's Department of Earth and Space Sciences are working on the Puget Sound Foraminiferal Research Project. Each working on their own part of the larger investigation, the students have a unique opportunity to gain skills for jobs in environmental companies or graduate school.

MALACOLOGY

THANKS TO THE GENEROSITY OF Dr. Phillip & Sandra Nudelman, 100,000 shells and the scientific data associated with them (locations, dates, habitat, etc.), will be incorporated into the malacology collection. Specimens like these can provide a critical baseline in a time of rapid change, when habitat alteration, overfishing, climate change, and ocean acidification threaten species.

IN A RECENT BIOSCIENCE study, Dr. Rowell and 16 colleagues showed a steep decline in natural history education, collections, and research. They argue that despite this downturn, natural history collections are essential to informing issues like wildlife conservation, human health, and food security. The study followed a series of UW- and National Science Foundation-sponsored workshops that focused on re-envisioning natural history's future: specifically, engaging budding naturalists through new technologies (like swapping iPhones for butterfly nets) to ensure natural history continues to play a key role in society.



Ancient Clam Gardens Inform Today's Shellfish Harvest

Finding ways to sustainably grow food for an increasing population is one of the major challenges of our time, and one humans have dealt with for millennia. Curator of Malacology Dr. Kirsten Rowell, her colleagues from Simon Frasier University, and members of Canada's First Nations are examining aspects of clam gardens, an ancient aquaculture technique along the British Columbian coast. The interdisciplinary team of ecologists and archaeologists are interested in how clam gardens worked, what species they targeted, how productive they were, and how they may help inform today's aquaculture practices in the face of ocean acidification. Clam gardens were built by rolling rocks down to the lowest tide line, thus building a retaining wall at distinct tidal heights. These engineered beaches extend and create ideal clam habitat and are a legacy of generations of intertidal management by First Nations people. By comparing several ancient clam gardens to un-walled, natural clam beaches, Dr. Rowell and her colleagues found in a recent study that clams grew almost twice as fast and were more likely to survive in clam gardens than on unmodified beaches in the same area. Clam gardens also contained four times as many butter clams and over twice as many littleneck clams, compared to the non-walled beaches. Coastal First Nations members further contributed to the findings through their traditional knowledge, sharing that their ancestors increased the beds' productivity by adding ground clam shells and pebbles to them.

This research is helping revive traditional knowledge that's been nearly lost. Through this work, Dr. Rowell and her colleagues are also raising awareness of a low-cost, low-environmental-impact alternative to today's shellfish harvesting practices.

Dr. Rowell is also examining if clam garden habitat can create a local buffer against the perils of ocean acidification. The sediment behind the walls consists of clam shell hash (broken down clams), and is essentially calcium bicarbonate—a natural pH buffer. This work will focus on the survival of newly settled baby clams and has large implications for today's aquaculture practices.

Top photo: Dr. Rowell and her colleagues canoeing to a field site. *Inset photo:* Dr. Rowell and a volunteer from the Tula Foundation sampling bivalve diversity in clam gardens on Quadra Island, B.C., Canada.
(TOP PHOTO: A. GROESBECK. INSET PHOTO: DR. MUNROE).

Who Were the First Farmers in Island Southeast Asia?

Although people have lived for more than 40,000 years in Island Southeast Asia, a vast tropical archipelago between mainland Asia and Australia, only in the last 3,500 years did they start making pots and farming. Archaeologists have long wondered about this change. Who were those first farmers, and why did they decide to suddenly shift from hunter-gathering—a way of life that had sustained them for so long?

Most scholars today believe that the first farmers in Island Southeast Asia were immigrants from Taiwan, who brought with them a new "toolkit" (pots, new foods, new stone and shell tools) as well as new languages. The immigrants displaced the older hunter-gather peoples everywhere except in New Guinea. These theories hold that people who live in this region today are the biological and cultural descendants of these migrants.

Dr. Peter Lape, Burke curator of archaeology, is finding new data that suggest hunter-gatherers weren't replaced by farmers; instead the first farmers were migrant fishers from nearby islands. By analyzing 3,000 to 4,000 year-old archaeological sites on small, remote islands with large coral reefs in eastern Indonesia and the southwest Philippines, he's finding many subtle hints that suggest the farmers were local fishers, as opposed to Taiwanese immigrants. These islands typically have plentiful fish but very little terrestrial fauna, and are usually "dry," with no fresh water sources besides rain. Artifacts found at the sites indicate the fishers adopted pots and plant crops to allow them to survive on dry islands and exploit virgin fishing grounds. About 100 years later, thicker pots, which are best for cooking but do not hold liquids well, are found in the sites. This, combined with the discovery of remains of domestic animals, indicates nearby reefs became less productive due to fishing pressure, and farming was subsequently further utilized by these people.

In the next year, Dr. Lape and colleagues will test this theory by surveying Seram, a large island in eastern Indonesia that has never been analyzed by archaeologists. They hope to find 4,000 to 5,000 year-old sites that span the hunter-gatherer to farming phase, and collect local paleoclimate data that may give hints about why people made this change when they did.

Top and inset photos: Dr. Lape excavating in the Banda Islands, part of the Indonesian province of Maluku.

ARCHAEOLOGY

PETER LAPE AND COLLEAGUES have created a new map about the history of Seattle's evolving shorelines. The map traces the pre-19th century shorelines of the dramatically-altered Seattle waterfront, the natural and human forces that shaped them, the ways they have been used by the people who live here, and how this historic understanding might influence urban-development decisions.

IN COLLABORATION WITH Coast Salish community members, Dr. Lape evaluated prehistoric diets by analyzing materials from archaeological sites in the Puget Sound region. Through the archaeological record and knowledge from elders, they've identified over 280 plant and animal ingredients that are part of traditional Coast Salish cuisine. These ingredients are helping revitalize food traditions and providing healthy diet alternatives.

Burke MUSEUM UNIVERSITY of WASHINGTON
VOLUME NO. 1 JULY 2014 ISSUE
Burke Museum Research Newsletter DISCOVER

HERPETOLOGY & GENETIC RESOURCES

UW GRADUATE STUDENT Jared Grummer and postdoctoral researcher Robert Bryson discovered a new species of lizard, *Sceloporus aurantius*, while studying lizard populations in southern Mexico. They developed a new way to conduct statistical tests of genetic variation to determine whether populations belong to the same species. They identified a unique genetic lineage and, upon closer examination of the new species, discovered that males have a unique orange color on their bellies during breeding season.

IN A RECENT STUDY, ADAM Leaché and graduate student Rebecca Harris quantified the impacts of genetic exchange on the evolutionary pathway of a species. By comparing multiple genetic markers with varying levels of migration between populations, they found that even when a species' evolutionary history is well known, transmission of genetic information across populations can cause scientists to overestimate the population size of a species, and underestimate when related species diverged.

It's in Your Genes: Discovering New Species

West African forest geckos are elusive but widely distributed lizards found in patchy forests from Ghana to Nigeria. The belt of tropical rain forests that once connected these geckos has fragmented over the past 100,000 years, isolating populations. The geckos still look similar, but are they still the same species? And how can we determine when species diverge from each other, becoming new species in their own right?

These are some of the questions being investigated by Dr. Adam Leaché, Burke curator of herpetology and genetic resources, and his lab. The team consists of 15 undergraduate, graduate, and postdoctoral researchers who are testing new genetic methods and developing new models to learn more about how species have evolved over time, the genetic variance among individuals of the same species, and how gene flow has influenced populations and resulted in new species.

Dr. Leaché's team created new algorithms and computer models that allow scientists to analyze not just portions of DNA, but an organism's entire genome. By using genome-wide single nucleotide polymorphism (SNP) data to estimate the probability of how often alleles (variations of the same gene) change among ancestors and descendants of a given species, Dr. Leaché found a common denominator that eliminates potential misclassifications or errors, which often resulted from using previous methods. This approach allows scientists to objectively determine when related species diverged from each other, even with a limited sample size. When applying this method to genomes of West African forest geckos, Dr. Leaché discovered four new species. These specimens are part of the Burke's genetic resources and herpetology collections, which can be examined by researchers from around the world.

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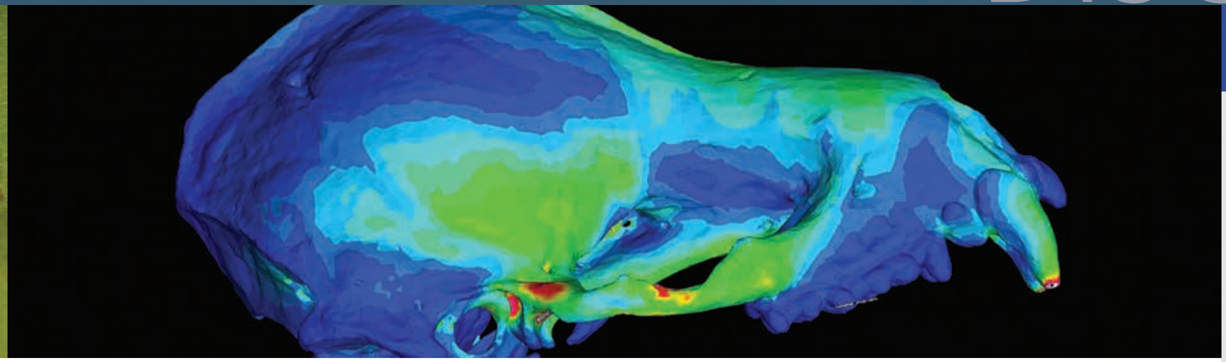
While Dr. Leaché's studies look at amphibians and reptiles, scientists from a wide range of fields can use these same methods and apply them to any type of life. The genome-wide SNP analysis and other methods are faster, more accurate, and more efficient. By analyzing the entire genome of an animal, plant, or other living creature, scientists can learn about how life came to be on this planet, and uncover the species that exist today.

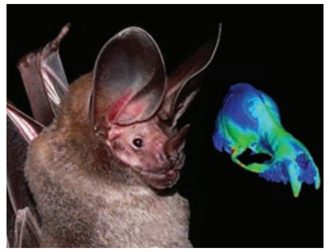
Top photo: West African forest gecko (*Hemidactylus kyaboboensis*). PHOTO BY CHARLES LINKEM.



New Approaches to Studying Biodiversity

One of the most salient patterns across the Tree of Life is that diversity is not distributed evenly. In mammals, groups like rodents and bats have evolved astonishingly high levels of diversity, consisting of thousands of species that span a wide variety of phenotypes and environments, while other mammal groups consist of few species that look similar to one another. How did these disparities in diversity arise? For many mammal groups, the answer to these questions involves an "ecological opportunity" process, in which their ancestors evolved anatomical and behavioral traits that allowed the exploitation of resources that other species could not access (for example, new food types).

Dr. Sharlene Santana, Burke curator of mammals, studies the integration of morphology (the structure/anatomy of an organism), function, behavior, and ecology of living mammals in the context of their evolutionary history to understand the mechanisms driving their diversification. Specifically, she and UW undergraduate and graduate students test evolutionary hypotheses to understand the mechanisms that generated the diversity of bats, primates, and other mammal groups.



Dr. Santana's previous work found fruit-eating tropical bats owe much of their astonishing diversity to ecological opportunity. In these bats, the evolution of shorter faces resulted in stronger bites, which allowed them to consume increasingly hard fruits other bats could not eat. Dr. Santana's lab is now investigating whether and how the same mechanisms could have produced the broad diversity of insect-eating bats, or if other aspects, such as variety in their echolocation abilities and structures, played a major role in their diversification.

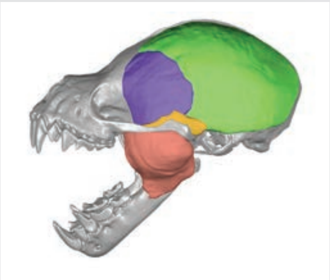
While Dr. Santana releases most of the bats she studies, she collects some specimens to document morphology, genetic, and ecological information. This year, Dr. Santana's team made an unprecedented addition to the Burke Museum's bat collection by recording bite force and feeding behavior data for each specimen, preserving fecal samples for diet studies, and making molds of the bats' ears and noseleaves for comparative analyses of these structures. Many of these bat specimens will also be imaged through micro-CT scanning. The specimens and their comprehensive data will be available for researchers all over the world to study, and preserved for generations to come.

Top and inset photos: A white-throated round-eared bat (*Lophostoma silvicolum*) and a finite element 3D model of its skull. Dr. Santana uses this engineering technique to investigate how the bite force of this and other bat species impacts their skull anatomy and function.

MAMMALOGY

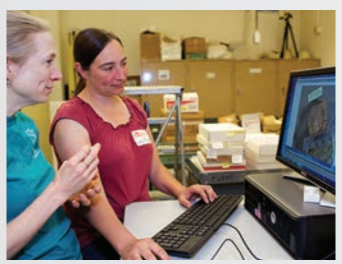
UW GRADUATE STUDENT Rochelle Kelly will be studying bat populations on Washington's San Juan Islands this summer. Last May, she led Burke Mammalogy's first preliminary survey of the bats on Vendovi Island, Washington. By collecting baseline ecological information of the San Juan bats, Kelly aims to better understand the patterns of diversity of temperate bats and inform their conservation and management.

THE SANTANA LAB IS conducting micro-CT scans on bat heads, creating detailed 3D models of the muscles bats use to open and close their jaws. This allows lab members to investigate muscle anatomy and function in unprecedented detail, and build computer models to simulate bite capacity across different bat species.



PALEOBOTANY

THE BURKE'S PALEOBOTANY collection has come far in the last six years! Since Dr. Strömberg started at the Burke it has nearly doubled in size, is now fully organized, and nearly half (~25,000) of the fossils have been catalogued. Currently, the specimens are being entered into an electronic database that will be available online, allowing researchers and the public to see photos of and read about the Burke Museum's beautiful plant fossils.



THE STRÖMBERG LAB RECENTLY started work on an exceptional site in Emerald Creek, Idaho. This 15 million-year-old lake bed boasts leaf fossils that are so well preserved that they sometimes come out green or with fall colors. This site also includes phytoliths and pollen, providing a remarkably complete picture of environments in the Pacific Northwest during the MMCO.

How did Grasses Completely Alter Earth's Ecosystems?

Imagine a world without grasses: no popcorn, cereal, bread, rice, pasta, tortilla chips... no bamboo floors, golf courses, or lawns. Half of Earth's land surface would be covered by a different vegetation type than it is today, and all of the animals that depend on grasses and grasslands—our own species included—would be without their natural habitat. Yet only 30 million years ago, the world lacked its many grass-dominated environments (savannas, prairies, woodlands) and 70 million years ago, grasses had not evolved—or so we think. How did one group of plants (grasses, or "Poaceae") completely alter Earth's ecosystems? How did this transformation influence the evolution of animals?

Curator of Paleobotany Dr. Caroline Strömberg and her students use plant fossils to answer these questions. Specifically, they study tiny crystals (phytoliths) that form inside tissue in living plants and are left in the soil—sometimes for millions of years—after the plant dies, offering evidence of what plants grew in a spot. Many types of grasses have unique phytoliths that allow the Strömberg lab to track the evolution of grasses and the spread of grasslands. To do so, they travel to field sites around the world (from the U.S.'s Great Plains to China and Argentina) that span in age from the Pliocene (3 million years ago) to the Late Cretaceous (100 million years ago). From cliffs where the rock is exposed, they collect samples from ancient soil horizons. Afterward, they treat the samples with chemicals to extract the tiny fossil phytoliths, which can then be studied using a microscope with very high magnification. With any luck, there are phytoliths from grasses and other plants preserved that can provide a glimpse into an ancient world.

In one of the Strömberg lab's ongoing projects, graduate student Elisha Harris is studying how vegetation structure and faunas changed in northern Idaho during the latest major warming event on Earth, the so-called Mid-Miocene Climatic Optimum (MMCO), 14–17 million years ago. By doing so, she will learn how ecosystems respond to global warming over longer timescales. This information might also be useful for predicting how our current ecosystems will fare in the face of anthropogenic climate change.

In another project, Dr. Strömberg and postdoctoral researcher Dr. Georgina Erra traveled to southernmost Patagonia to collect rocks from the time of the dinosaurs. They hope to trace the steps of the earliest grasses, which are thought to have lived in South America, to better understand what kinds of environments allowed these remarkable plants to evolve.

Top photo: Caroline Strömberg and postdoctoral researcher Georgina Erra collecting phytolith samples in Argentina.

What Sparked Earth's Richest Plant Diversity?

The New World tropics, or Neotropics, from Mexico in the north to Argentina in the south, contain the richest diversity of flowering plants on earth. Understanding how that tremendous diversity came to be, over time and across the landscape, is the focus of Burke Curator of Botany Dr. Richard Olmstead's research. By using DNA-based phylogenetic trees of plant groups widely distributed throughout the Neotropics and comparing the dynamics of diversification within and between biomes, Dr. Olmstead's lab is addressing questions such as: when and how did these plants that originated in South American move to North America? What is the role of long-distance dispersal? Does evolution into new biomes result in increased rates of diversification?

Specifically, Dr. Olmstead's lab studies the Solanaceae (potato), Bignoniaceae (trumpet creeper), and Verbenaceae (verbena) families. These families originated in South America 40–50 million years ago, when the continent was isolated from other landmasses. Dr. Olmstead has found that a very limited number of long-distance dispersal events can account for all of their Old World representatives. By contrast, 24 of 31 major branches in these three family trees dispersed within South America and migrated to North America, where they have similar northern and southern latitudinal limits commonly coinciding with frost-free regions. The seven branches that didn't make it have an average of only eight species each, so their failure to migrate might be more related to their failure to diversify. These results suggest that constraints of physiology are more important in determining the distributions than their ability to migrate from ancestral home ranges in South America.

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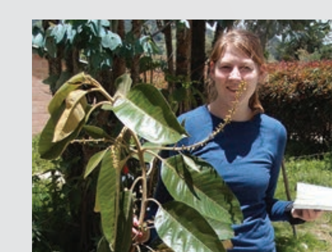
Similar studies of plants usually have been done on much smaller, younger groups that haven't dispersed or diversified as greatly as the families studied by Dr. Olmstead's lab, thus generalizations based on those studies may be misleading. Continuing work on Bignoniaceae and Verbenaceae by graduate students in the Olmstead lab and colleagues at institutions in Argentina and Brazil will expand the number of species sampled and will include methods to date the branching points in evolutionary trees, enabling interpretation of diversification throughout the Neotropics at a scale not previously attempted.

Top photo: Aloysia velutina (Verbenaceae). Department of Cuzco, Peru.

BOTANY

PAT LU-IRVING'S RECENT dissertation explored the diversification of Verbenaceae tribe Lantaneae, a group of nearly 400 species. She found the group originated in the arid regions of temperate South America, and then spread throughout the New World, including tropical regions. They have avoided wet tropical forests, except for a few species that specialize in openings, making them good colonists in disturbed habitats.

PH. D. STUDENT LAURA Frost's research assesses the relative importance of niche conservatism (diversification within similar habitats) and niche evolution (adapting to novel habitats) in the tropical tree genus *Citharexylum* (Verbenaceae). With distribution ranging from the wet tropics to the Sonoran desert scrub, *Citharexylum* is an ideal subject for her research.



DISCOVER...

A REVOLUTION IN GENOME SEQUENCING, PROTECTION FROM OCEAN ACIDIFICATION, A WORLD WITHOUT GRASSES, THE SECRETS OF BELLINGHAM BAY, THE FATE OF A MISSING CARVING, RED LEAF FOSSILS, 3-D MODEL BAT SKULLS, THE DOUBLEHOOKED SNAGGLETOOH SEADEVIL.

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