The Value of Museum Collections in the 21st Century

By Roberta A. Lee, MD and Michael J. Balick, PhD

In my (R.A.L.) small office are various artifacts that I have collected over the years from my medical and ethnobotanical travels. One of these artifacts lies on my bookshelf: two round stones the size of my palm used to pound sakau or kava (*Piper methysticum*). These compact orbs, about twice as heavy as a paper weight, fall as if magnetized to the earth, making them perfect for long hours of pounding. Perhaps they are more than 20 years old, and if my estimates of sakau use are correct, it's possible that these stones may have participated in 3,000 evenings of sakau pounding. Hanging on the walls of my colleague's (M.J.B.) office is a variety of spears and clubs used for hunting boars, jaguars, and other animals. These sacrificed animals potentially provided the only protein for several families for months, making them coveted property of their original owners and extremely special gifts because of their utility and symbolism. My colleague's collection was gathered 30 years ago before shotguns became the tool for hunting in these regions. Our respective families and neighbors have found these things curious–especially the neighborhood children. These items have transported them, through our hours of narration, into another place, another time, conveying the vision of lesser-known worlds.

Everyone collects objects of interest–my father collected stamps. My earliest school trips were to a natural history museum. These museums, often filled with dinosaur models, stuffed exotic animals, live insects, and/or gems and minerals are the first memories of science for most children. Thus, such well-curated collections serve a vital public function, helping us appreciate our relationship to living things in the world. Behind the public face of natural history museums are thousands, sometimes millions, of specimens in categories ranging from zoology, anthropology, botany, entomology, and paleontology to mineralogy. For scientists, these collections provide a great deal of understanding of the relationships of structure, function, and development to the communities and ecosystems from which these items are collected. They also serve as huge three-dimensional libraries that describe the organisms that exist or have existed on the earth during its history. For instance, I can still see what a dodo or passenger pigeon looks like although I could never find one in the wild. Comparing things across time can often reveal new information that can be the basis of a better understanding of how time and changing circumstances alter a species–which could be plant, animal, or mineral. Yet sadly, as economic resources have declined, museums have faced great challenges in maintaining specimens, and worse still, their value to contemporary society has sometimes been questioned.

However, exciting new and novel uses of archival specimens in modern scientific research are emerging. Recently, Wayne Law, a graduate student in ecology from Washington University at St. Louis, Missouri, and Dr M. Jan Salick, a conservation biologist from the Missouri Botanical Garden, investigated the morphological changes of plants collectively known as the snow lotus (*Saussurea laniceps and Saussurea medusa*), comparing their field observations with data from historic museum collections. The snow lotus, particularly *S. laniceps*, is highly prized for its medicinal properties in Tibetan and Chinese medicine. *Saussurea laniceps* is preferentially harvested and used for treatment of high blood pressure, headaches, and menstrual problems because it is believed to be more potent and efficacious. The smaller *S. medusa* is not collected as vigorously. Both varieties of the snow lotus are endemic to the eastern Himalayas, growing in rocky habitats over 4,000 meters. In the last 30 years, harvesting has increased due to a growing interest in Chinese medicine and novel plants from exotic locations. The snow lotus has been harvested as a souvenir because it looks so unusual. Unfortunately, its harvest has been at the only flowering period before setting seed. The consequence of this gathering practice means that plants that look robust or are larger and thus more enticing are gathered as specimens for medicine or for sale to tourists. When harvested prior to setting seed, their potential progeny are prevented from becoming part of the plant population, no new genetic material is introduced into the group, and the weaker (eg, less desirable) and less robust specimens are the only ones left to continue seeding. Observing this phenomenon in nature motivated Law and Salick to ask, what if any changes could be documented from such a heavy selection process, and how best to prove that these changes took place over time? Plant collections from eight herbaria that had served as the main repositories for specimens collected by early explorers in the area of Yunnan, China where the snow lotus grows were used as comparisons from the market samples collected by Law. Some of the earliest herbarium collections dated back to 1872, and these plants, including over 218 *S. laniceps* and 309 *S. medusa*, were measured. Plant specimens of *S. laniceps* and *S. medusa* from modern stock were also selected for measurement, obtained from several sites in heavily harvested areas and sacred Tibetan protected sites. Snow lotus plants of both varieties were measured and their sizes compared according to location gathered and time of harvest and/or date of collection. Her-

Law measuring a snow lotus in Deqin County, China.

barium specimens gathered over a 100-year period were carefully studied and revealed a marked pattern of diminished size of *S. laniceps* over time. Additionally, *S. laniceps* gathered from heavily harvested areas were found on the average to be 9 cm smaller than plants in low-harvest areas. In contrast, *S. medusa*, the less preferred and less harvested variety of snow lotus, showed no change in size in either herbarium specimens or modern field samples gathered. The authors suggested that the conscious and subconscious harvest of larger plants left weaker and smaller plants with lower seed yields. The preferential selection

The Menri Snow Mountains, sacred mountains of Tibet.

created conditions resulting in the rapid dwarfing of plants. The study, published in the *Proceedings of the National Academy of Sciences of the United States of America*[1] in 2005, underscores the value of herbarium specimens in tracking phenotypic changes in plant populations and thus has made a significant contribution to the field of conservation biology.

As a first generation Taiwanese-American, Law recalls that the use of botanicals for medicine in his family was quite commonplace. Intrigued by these practices, he had initially decided as a child that he would become a physician. However, during his undergraduate years–by chance and out of a love of adventure–he decided to take an ethnobotany course. The course awoke within him a curiosity of plants, people, and culture. Eventually he signed on for more ethnobotany courses and ended up traveling to the Yucatan peninsula, where he assisted a graduate student in collecting plants for a floristic checklist of the area.

As he looks back, Law finds that one of the most compelling reasons for his work is the need to save plant species in danger of extinction. He recalls one of the earliest bittersweet moments occurred when he interviewed a local medicinal plant collector. The collector shared with him his awareness of the snow lotus's shrinking size and harvest numbers. Nonetheless, despite his realization, the collector reluctantly acknowledged that he was compelled to continue harvesting the snow lotus because he needed to make a living. Others Law interviewed echoed these views. Law feels that ecologists and ethnobotanists such as he can play an integral role in preserving biodiversity by uncovering the intricacies of plant reproductive cycles and human influences thru unique management and study methods (personal communication, 2006).

At The New York Botanical Garden (NYBG), a collection of medicinal and other useful plants gathered systematically throughout the world during the late 1800s and early 1900s was developed by Henry Hurd Rusby (1855-1940), a botanist and physician who founded the study of economic botany at that institution. He carried out many expeditions to Central and South America, as well as collecting samples used in pharmacy. Three days after receiving his medical degree in 1885,

Snow lotus (*Saussurea laniceps*) drying in the market.

he led a two-year expedition to South America, sponsored by Parke, Davis, and Company, in search of pharmacologically active plants.[2] The collection of useful plants formed the basis for the Economic Museum at NYBG, which opened in 1899 and closed in the 1930s. When closed, the exhibition was placed in storage and no longer curated. Recently a multidisciplinary team of chemists, pharmacologists, and botanists, evaluated one of these historic collections, a sample of black cohosh (*Actaea racemosa* L.) collected in 1919 and presented to Rusby by Park, Davis and Company.[3] In many Native-American medicinal practices, black cohosh was used to treat general malaise, malaria, rheumatism, sore throat, and menstrual irregularities. In the last 40 years, black cohosh has received a great deal of interest and investigation for its use in menopause. Retail sales of black cohosh ranked ninth in retail market sales in the United States. This 85-year-old plant was studied by the team and compared to a modern collection of *Actaea racemosa*. Pharmacologically, two classes of chemicals are found in black cohosh–triterpene glycosides and phenolics. Over 40 triterpene glycosides have been identified in black cohosh along with other constituents, including a tannin and oleanol triterpene glycoside. However, for purposes of comparing the possible change in chemistry of the 95-year sample and comparing its "shelf life" to what might be expected to be found in the modern sample, four major triterpene glycosides were studied and found to be similar in the older Rusby specimen and its modern day counterpart. Additionally, the antioxidant activity was also similar between the two specimens, but the total content of six major phenolic constituents was found to be lower in the Rusby specimen as compared with the modern plant sample.[3] The findings suggest a great deal more chemical stability than would have been expected from the prolonged storage of this particular herbal remedy. Indeed, most commercial preparations of botanicals have expiration dates of only two or three years. Is it possible, given these results–at least in the case of black cohosh–that longer periods of shelf life could be expected? This is the kind of scientific question that can only be asked if historic collections are available for study by contemporary researchers. The Rusby Collection, now being curated at NYBG by a group consisting primarily of volunteers, offers a wealth of potential answers as to the stability, identification, genetics, and chemistry of these plant-derived products, so many of which are over a century old. If we are able to infer atmospheric composition by sampling the air in a sealed bottle of 100-year-old spirits, then certainly collections such as this can give us insight as well. Tragically, we know of other such collections of 18th- and 19th-century medicinal plants that still exist in institutional basements, rich collections of which the staff is unaware of the value.

Similarly, chemical stability has been recorded in samples of *Banisteriopsis caapi*, a psychoactive plant used by indigenous peoples in the Amazon Valley. A 106-year-old sample of *B. caapi* was found in a collection made the 19th-century British botanist Richard Spruce. The Spruce specimen was found to have a β-carboline alkaloid responsible for the psychoactive response, known as harmine. A modern specimen of this plant was evaluated for comparison and found to have the β-carboline alkaloid harmine as well has tetrahydroharmine. This latter compound, tetrahydroharmine, was suspected to be present in the initial 106-year-old sample, but because of its chemical instability, the authors hypothesized that it was converted to the more stable β-carboline alkaloid.[4] Again, the study of historic materials–comparing them with contemporary specimens–illustrates the usefulness of collections, for example, in the temporal assessment of compounds and their stability.

The NYBG is, among other specialties, a center for applied botanical research, particularly with medicinal plants, because of its contemporary commitment to its collections. These collections grow each year as botanists explore the most remote regions of the planet, as well as the local markets of New York City. Two of NYBG's many premier collections are The LuEsther T. Mertz Library–nearly 550,000 books and journals that span plant science, landscape design, and horticulture–and the William and Lynda Steere Herbarium, containing 7.2 million preserved plant specimens available for study by plant taxonomists and others interested in learning about the diversity of the plant world. As botanical medicine becomes more sophisticated in its need to evaluate and document material under clinical study, collections such as these assume greater importance as reference tools. In the future, plant DNA will form the basis for a barcode that can identify an individual plant species and even individual populations of plants, providing scientists with accurate determinations of plants and plant parts, both in the field and from individual vials of dried and ground plant tissue previously unable to be confirmed with certainty. It is commonly understood that science moves forward by present-day practitioners standing on the shoulders of their predecessors. It is less frequently acknowledged that the collections made centuries ago by these predecessors are even more important today as baseline data for how organisms have changed.

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Roberta A. Lee, MD, *is medical director at the Continuum Center for Health and Healing at Beth Israel Medical Center, New York. She is co-director of the Integrative Medicine Fellowship. Her research involves ethnomedicine, the study of healing systems used by traditional cultures.*

Michael J. Balick, PhD, *is vice president and chair of Botanical Research and training, philecology curator and director, Institute of Economic Botany, The New York Botanical Garden. An ethnobotanist, he studies the use of plants by traditional cultures.*