

Members of the Consortium of Northeastern Herbaria held their annual meeting at the New York Botanical Garden June 25-26, hosted by Barbara Thiers, director of NYBG.

Patrick Sweeney opened the meeting, the 8th annual meeting of the Consortium, by introducing the morning's talks on the use of digitized herbarium data for research.

Richard Primack from Boston University presented the first talk, in which he showed how herbarium specimens can be used to study the effects of climate change, the spread of invasive species and the effects of land use change on a region's flora, among other research questions. Online specimen data makes it possible to obtain data from a region without having to actually travel there, he said, and the data then can be used in combination with field observations, remote sensing or data accumulated through citizen science projects. Much of the recent work done by Primack's research group has used herbarium data to analyze changes in phenology, especially changes in flowering time, in the past 100 years. These analyses have shown that most plants now flower earlier – on average 3 to 5 days earlier for each 1° C increase in temperature, he said. He said his group's research also has found that common trees are leafing out earlier in the spring and that this is most closely related to April temperatures, with leaf-out later in cold years. The timing of leaves' emergence is important because it relates to when trees start to withdraw carbon from the atmosphere each year, he said. He has recently begun to look at changes in fall phenology, especially changes related to when trees produce their fruit, which birds rely on to fatten up before beginning their fall migration. Any asynchrony caused by earlier fruit production and later bird migration could have serious consequences for the migrating birds' condition, he said. It appears, however, that the birds now are relying more on invasive plants as their pre-migration food sources because those spaces fruit later than native trees on average. Moreover, there does not appear to be any change in trees' fruiting time related to temperature so there is no evidence at this point that trees are fruiting earlier than in the past, though the reasons for this to be explored further, Primack said.

Wayne Law from NYBG spoke about a new method being developed to assess species' risk of extinction. The IUCN uses information on how widespread species are to determine which are at risk, but only about 5 percent of plants have been assessed at all, in part because the assessment process takes so long to complete. He and his colleagues are using new criteria to speed up the process, declaring that species are not at risk if they occur in an area of more than 20,000 km² or if they occur on three or more continents. This method has been tested successfully in Puerto Rico, where 570 of 2015 native plants were found to be at some risk. The method is now being tested more widely, throughout the West Indies.

Elizabeth Spriggs from Yale spoke about her research, which has used herbarium specimens and newly collected material to analyze how evolution has affected *Viburnum* leaf morphology and the selective advantage of particular traits in different climates. She said *Viburnum* leaves in temperate areas have rounder, more dentate leaves than *Viburnum* leaves in tropical areas and that various theories had been proposed to explain the differences, all assuming that the differences were related to variation in temperature. However, Spriggs said that she is exploring

the possibility that the differences are related instead to leaf development. She has found that leaf shape varies greatly on the same plant, depending on the time of emergence, with early emerging temperate leaves being wide and toothy but that later leaves on the same plant appear little different from narrow tropical leaves without teeth. This supports her hypothesis that rounder, more dentate leaves occur on temperate species because their early emerging leaves are preformed, developing in the bud at the end of the previous growing season, unlike tropical leaves that develop only during the present growing season, which is the ancestral condition in the genus. Therefore, Spriggs said, the changes in shape are only indirectly related to temperature and result more directly from the selective advantages of preforming leaves, which requires that leaves pack efficiently into a bud, as wide, dentate leaves do.

James Lendemer from NYBG spoke about the value of cryptogamic data in the biodiversity information synthesis. Lendemer said many lichen species are declining for a number of well-known reasons, including pesticides and other pollutants, fire, logging, habitat loss and invasive species. The New York Botanical Garden has about 250,000 lichen specimens in its database, the largest online collection in the Western Hemisphere. However, he said that all data aren't equal: Collections have many biases, including taxonomic biases and biases related to where specimens were collected. In addition, misidentification of lichen specimens is high – often 60-80%, he said. Because of these biases, the results of data analyses can be misleading or ambiguous. Lendemer spoke about his efforts to ensure that NYBG's specimens are identified correctly and about his use of the specimens to identify areas that are under-represented. As a result of this analysis, he and others have been collecting aggressively on a particular peninsula in North Carolina that is largely undisturbed but where lichen richness is very high.

Dorothy Allard from the University of Vermont herbarium spoke about an effort to protect endangered plants by suppressing precise location information that otherwise would be available through the CNH specimen data portal. Allard, who serves on Vermont's endangered species committee, said that she has been working with a committee that has now developed a procedure through which any state's Natural Heritage program can produce a list of species for which they would like to have location information suppressed. The list need not include all endangered species, she said. For example, it may not be necessary to suppress information on rare plants that are of no commercial or medicine value. The idea is to protect plants that might be lost to unscrupulous collectors. Data can be suppressed in several ways, Allard said. For instance, systemwide suppression has been applied for all orchid species. In addition to suppressing location data, the procedure suppresses images of the specimens, she said. Access to the suppressed data and images can be granted to selected individuals who have a legitimate need to see the information.

Pam Polloni, curator of the herbarium at the Woods Hole Oceanographic Institute, gave the final presentation of the morning session, talking about restoration work that is being done on a former cranberry bog. The town of Falmouth began buying pieces of the Coonamessett bog in 1971, taking the bog out of production and restoring newly acquired areas to their more natural condition, using the herbarium to determine what plants occurred along the Coonamessett River

historically. Since then, Polloni and other botanists have been recording changes in the vegetation. A total of 132 species have been recorded, of which 102 are native and 101 are herbaceous. Dams and dikes also were removed from the Coonamessett River and native brook trout and herring now are increasing.

After a break for lunch, Sweeney led the Consortium's business meeting. Tatyana Livshultz from the Academy of Natural Sciences in Philadelphia said that a Thematic Collections Network proposal is being prepared for submission to the NSF that would create a Mid-Atlantic herbarium portal for specimens in Pennsylvania, Delaware and Maryland. The latter two states are not members of any regional consortium. There was discussion about the need for an additional portal and the possibility of inviting herbaria in the two states to join CNH. Sweeney said officials from iDigBio and the U.S. Virtual Herbarium project are continuing discussions about the creation of a nationwide portal.

Sweeney asked those at the meeting whether there were new projects the Consortium should undertake, now that the digitization of major collections in the region has been underway for several years. A number of people suggested that digitizing smaller collections remains an issue that has not been addressed completely. There are many of these. In addition, a number of larger collections have not yet been captured on the CNH portal, including the University of Maine, the Brooklyn Botanical Garden, Cornell and the Rochester Academy of Science. Sweeney said that Chris Campbell at UMaine would be eligible to serve as the PI on a Partner to Existing Network grant that could digitize smaller collections throughout the consortium's region and that he would discuss this possibility with Campbell.

Following the conclusion of the business meeting, Barbara Thiers led a tour of the NYBG herbarium and library, showing CNH members areas where specimens were being imaged as part of digitization projects, areas where recently collected specimens were being mounted and the herbarium itself where specimens are stored in compactors. Greg Plunkett provided a tour of molecular biology laboratories, and Stephen Sinon led a tour of the Mertz Library, proudly displaying a few of the library's many special items, including books by John Bartram and John Torrey's vasculum.

The second day of the meeting was devoted to a workshop on cleaning digitized data, led by Paul Morris and David Lowery. They explained the advantages of using FP-Akka software, which was developed through the Kurator project. The software makes it possible for curators at individual herbaria to download their data from the CNH portal and to check it for errors and inconsistencies. The software relies on online taxonomic sources, a database of collectors' birth and death dates, and geographic references to check the specimen data for errors. It can find, for instance, if the database indicates that a particular specimen was collected by a person after his death or if a specimen is reported to have been collected at a latitude and longitude that fall outside the nation where the specimen was collected. Morris and Lowery then helped CNH members configure their own computers to download and use the software.