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SHORT COMMUNICATION

PTIS Potato Herbarium Transferred to WIS, the Wisconsin State Herbarium

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Abstract
The Potato Introduction Station in Sturgeon Bay Wisconsin has maintained herbarium specimens as part of its operations. These specimens mostly were grown from seeds in the field plots or greenhouses, but also include original specimens made during germplasm collecting expeditions. The herbarium of the Station (herbarium acronym PTIS) has been transferred from the potato genebank in Sturgeon Bay Wisconsin to the Wisconsin State Herbarium (acronym WIS) in Birge Hall, University of Wisconsin-Madison where it is now fully integrated and curated and funded by WIS; PTIS is discontinued and is no longer maintained as a separate herbarium. Separately, maps and taxonomic literature that were used by the potato taxonomist in Madison were transferred to the Potato Station in Sturgeon Bay.

Resumen
La Estación de Introducción de Papa en Sturgeon Bay, Wisconsin, ha mantenido especímenes de herbario como parte de sus operaciones. Estos especímenes se cultivaron en su mayoría de semilla en lotes de campo e invernaderos, pero también se incluyen especímenes originales hechos durante expediciones de colecta de germoplasma. El herbario de la Estación (acrónimo PTIS) se ha transferido desde el banco de germoplasma de papa en Sturgeon Bay, Wisconsin, al herbario del Estado de Wisconsin (acrónimo WIS) en Birge Hall, Universidad de Wisconsin-Madison, donde ahora esta completamente integrado y curado y respaldado por WIS; PTIS esta descontinuado y ya no es mantenido como un herbario separado. Aparte, los mapas y la literatura taxonómica que se usó por el taxónomo de la papa en Madison, se transfirió a la Estación de la Papa en Sturgeon Bay.

Keywords Herbarium · Potato · *Solanum*

Before 1950 and before the US national plant germplasm system was started, various scientists and breeders imported potato breeding stocks ad hoc. Potato scientists lobbied for a centralized program to import, classify, preserve, evaluate, and distribute potato germplasm. The University of Wisconsin Research Farm (Peninsular Agricultural Research Station) at Sturgeon Bay Wisconsin was chosen as the home of the U.S. Potato Genebank in 1948. It was the first inter-regional project (all US Agricultural Experiment Stations contributing) so was long recognized as "IR-1". The genebank is still funded inter-regionally, but now the USDA Agricultural Research Service contributes major funding, and the University of Wisconsin also provides substantial infrastructure and administrative support.

The potato germplasm collection was built from a long series of potato collection expeditions starting in the nineteenth century when Mexican wild potatoes were collected for use as a source of resistance against *Phytophthora infestans*, the pathogen that caused the Irish potato famine. The first large-scale germplasm collections of potatoes were by the Russian workers S. M. Bukasov, S. W. Juzepczuk, and Y. Kameraz, who collected in Mexico, Central America, and South America in the 1920s and 1930s. There were major

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British expeditions to Mexico and South America in the 1930s, conducted by E. Balls, N. Balls, and J. G. Hawkes, and Hawkes later collected in many other countries. Significant collectors in addition to those mentioned above are C. Ochoa and A. Salas for South America, K. Okada for Argentina, and R. Tarn and colleagues for Mexico. David Spooner was hired as the genebank taxonomist in 1986 and collected wild (mostly) and cultivated potatoes for the genebank every year from 1987 to 2000 in Mexico, Guatemala, Honduras, Costa Rica, Panama, Venezuela, Colombia, Ecuador, Peru, Bolivia, Argentina, and Chile. John Bamberg collected extensively in the southeast US every year since 1992.

Currently, there are approximately 5100 accessions (wild or cultivated species collections) in the potato collection that are active (have living germplasm). Of these living collections, approximately 3700 have herbarium samples (72%). Considering duplicate specimens, there are approximately 15,000 herbarium samples, which represent approximately 3900 plant introduction collections (this includes living and non-living [inactive] collection records). There are 5400 total accessions and 3900 with specimens (68%). The majority of the accessions with herbarium specimens are the wild species accessions. The cultivated accessions are not as thoroughly represented in the herbarium.

Herbarium specimens document the morphology of a plant in order to serve as a permanent reference point for species identifications and locality and other collection data. Typical herbarium specimens consist of living specimens pressed flat between cardboards, often intercalated with softer blotters and then dried in moderate heat in ovens or other methods, and then affixed (mounted) on archival herbarium sheets and organized and stored in insect-free cabinets (herbarium cases). Properly prepared and curated herbarium specimens can last hundreds of years and serve as critical elements to genebanks and taxonomic research. In October 2017, the entire herbarium collection of *Solanum* herbarium specimens (in addition to some *Daucus* specimens assigned as a new collecting task to D. Spooner) stored at the Potato Introduction Station (PTIS) in Sturgeon Bay was formally and permanently transferred to the Wisconsin State Herbarium (WIS). This scientific collection (WIS) is considered one of the largest in the world with holdings of approximately 1.3 million specimens of plants, fungi, lichens, and algae. Researchers from across the USA and abroad routinely visit the herbarium to examine specimens or request temporary loans of material of interest. In recent years, hundreds of thousands of specimens within the collection have been digitized and made available freely via the internet (https://herbarium.wisc.edu).

Figure 1 is a photo of a herbarium specimen of *Solanum candolleanum* recently transferred to the herbarium and Fig. 2 is a close-up of the herbarium specimen label showing the information available for all of the transferred specimens.

Fig. 1 A typical herbarium specimen of *Solanum* transferred to WIS, the Wisconsin State Herbarium

Eventually the entire WIS collection will be made accessible in this way. Currently none of the transferred specimens are available online. WIS is a unit maintained by the Department of Botany at the University of Wisconsin-Madison and is located within Birge Hall on the university campus. The facility is open to the public during regular hours on weekdays or by appointment. Professor Ken Cameron currently serves as its faculty Director, and two full-time scientific curators are employed at WIS, along with several students, emeriti researchers, and citizen volunteers. WIS entered into a similar transfer agreement with the USDA several years ago when it was determined that a large set of herbarium voucher

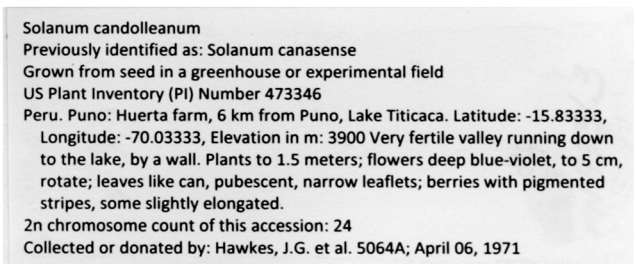

Fig. 2 A close-up of the herbarium specimen label of Fig. 1, showing the information included on all of the newly transferred specimens to WIS

specimens associated with the US Forest Service's wood collection (herbarium code MADw) would be better accommodated in modern archival cabinets within the herbarium's two-floor facility. The curators of WIS are committed to ensuring the long-term storage and protection of the PTIS specimens as well.

A critical set of information for a germplasm collection contains detailed, accurate and georeferenced locality data. The initial collecting expeditions were made before the ready availability of lightweight GPS devices. Today, however, the procedure is reversed, with locality data often determined only after latitude and longitude data are obtained with modern lightweight accurate devices. We purchased topographic maps at various scales, organized them based on international numbering standards (Parry and Perkins, 1987), and bound the maps into country-specific books. Valuable components of the herbarium resources are these bound maps from Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Panama, Peru, and Venezuela.

The taxonomy of section *Petota* traditionally has been difficult and subject to various interpretations of the number of species and their interrelationships. Spooner et al. (2014) recognized 107 wild species and four cultivated species, a large reduction from that of Hawkes (1990) who recognized 228 wild species and seven cultivated species. Because the initial identifications of the collection were made by Hawkes, Ochoa, and others, a chronological history of taxonomic changes is available from the Germplasm Resources Information Network, GRIN (https://www.ars-grin.gov/). The specimens are now organized alphabetically by species following the taxonomy of Spooner et al. (2014) but the identification label Fig. 2 maintains the Plant Introduction number in GRIN where the history of identifications is maintained.

Taxonomic literature is also a critical component to genebank operations as it provides the original descriptions necessary to revise the taxonomy and provides locality data to plan expeditions. We aggregated and organized all of this literature (Bukasov, 1930, 1933, 1971; Berthault, 1911; Bukasov & Kameraz, 1959; Castronovo, 1949; Centro Internacional de la Papa (CIP) et al., 2015; Contreras & Castro, 2008; Correll, 1952, 1962, 1967; D'Arcy, 1986; Gentry & Standley, 1974; Gorbatenko, 2006; Hawkes, 1944, 1956, 1963, 1990, 2004; Hawkes & Hjerting, 1969, 1989; Hawkes et al., 1979, 2000; Hunziker, 2001; Kardolus, 1998; Lekhnovich, 1971; Morton, 1976; Nee, 1993; Nee & Symon, 2000; Ochoa, 1962, 1990, 1999, 2003; Rodríguez-C. & Vargas-P, 1994; Rybin, 1929, 1993; Spooner et al., 2004, 2014; 2016, 2019; Vargas, 1949, 1956) as listed in the References, with much of it old and difficult to obtain. These are now curated, with the maps, at the Sturgeon Bay Genebank. These extensive collections are not digitized but limited requests through a telephone call or email to the genebank can be scanned and sent to those needing a rare reference.

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