American Crossroads
Digitizing the Vascular Flora of the South-Central United States

Presented by Peter Fritsch, for the participants of the TORCH TCN
The South-Central United States

Defined here as the states of Oklahoma and Texas

876,859 km², 11% of the contiguous U.S.

17 Level-III ecoregions as defined by EPA

East to west, links mesic forests with interior arid grasslands and deserts

North to south, links temperate and subtropical biomes

“American Crossroads” of North American ecological and biological diversity; key element in understanding continent-wide patterns of biome evolution
Extreme environmental gradients

East to west, mean annual precipitation >150 cm to < 12.5 cm (1 cm every 10 km); landscape tilts from sea level to 1300 m; abrupt peaks in W TX and Ozarks

North to south, mean January temp 0°C to 18°C though 5 plant hardiness zones
Intricate patchwork of geology and soils

Surface exposures range from Holocene alluvial deposits to 1.6 billion-year-old outcrops

100 different major soil types
Plant diversity in Oklahoma and Texas

4945 native vascular plant species in 213 families, constituting 31% of all native species in North America north of Mexico

Texas second among states in vascular plant species diversity, and 325 plant taxa are restricted to the state

Richest centers of plant diversity are the Ozark Highlands, Big Thicket, Edwards Plateau, and Trans-Pecos Texas
Threats to plant diversity in Oklahoma and Texas

Overgrazing, oil and gas extraction, exotic and invasive organisms, fire suppression, pollution, hydrological changes, urbanization
Threats to plant diversity in Oklahoma and Texas

Two globally ranked hotspots, i.e., the North American Coastal Plain (Gulf Coastal Plain) and the Madrean Pine-Oak Woodlands (Trans-Pecos region)
Documenting the plant diversity of Oklahoma and Texas

The 41 largest herbaria of Oklahoma and Texas contain ca. 1.7 million specimens collected within these states. They comprise a mix of large (> 1 million), mid-sized, and small herbaria. Several herbaria outside the region hold critically important historical collections (prior to ca. 1900).
Documenting the plant diversity of Oklahoma and Texas

Heat map of digitized collections of vascular plants in the iDigBio database for the southern half of the U.S. (2018)
Consequences of the gap in plant digitization in the South-Central United States

Plant species richness in the contiguous U.S. is concentrated in the southern half of the country.

Most of the land area within biodiversity hotspots of the U.S. is also situated in the south.

The edges of many plant species distributions occur somewhere within the region. Peripheral isolates often have unusual morphological or genetic traits.

The steep environmental gradients in the region can produce dramatic clines within species.
The Texas and Oklahoma Regional Consortium of Herbaria (TORCH)

Formed in 2008

Advocates for the herbaria of Oklahoma and Texas

Steering Committee of nine members and website (https://www.torcherbaria.org/)

Digitization has been occurring to various degrees at many of the TORCH herbaria

Ten TORCH conferences have been held more or less annually since 2010
Objective: establish a TCN under the auspices of TORCH for digitizing vascular plant specimens collected in Oklahoma and Texas

Disseminate the digitized data through an integrated Symbiota platform

Develop and implement innovative strategies to increase workflow efficiency

Recruit and engage students and citizen scientists in project-based broader-impact activities
Specimens and herbaria

Ca. 2 million specimens total, 1.7 million from 41 TORCH herbaria and 0.3 million from 5 herbaria outside of Oklahoma and Texas (plus NMNH)
Grant organizational structure

Herbaria: 5 Leads, 11 Subawards, and 31 Providers

Personnel:

Project Directors: The 6 PIs of the 5 Leads (Collaborative proposals): P. Fritsch (BRIT-Primary Lead), M. Fishbein (OKLA), A. Moore, B. Hoagland (OKL), D. Spalink (TAMU), G. Yatskievych (TEX)

Executive Team: the 6 PIs plus a full-time Project Manager, a full-time Data Manager, and a 0.3-time Technical Innovator (J. Best)

16 Institutional Coordinators (at PI and Subaward herbaria)

TORCH Steering Committee in advisory capacity, at annual meeting
Workflow innovations

- Image capture client for quality control and metadata capture
  - Blur detection and other QC measures
  - Immediate file rename based on barcode/catalog number
- Centralized backup of raw images immediately after capture
- Centralized automated image processing
  - Color correction
  - Application of technical and descriptive metadata
  - Conversion to DNG
  - Generation of JPG web derivatives
- Fast image and skeletal metadata ingest into TCN portal
- Centralized OCR and text analysis
  - Organizing specimens into thematic groups across all participants for NfN Expeditions
Hypotheses relating to the biodiversity of Oklahoma and Texas

1. Patterns of phylogenetic diversity and species richness will exhibit complex relationships with respect to ecological and spatial gradients
   a. Phylogenetic diversity is expected to decline with increasing latitude, as tropical and subtropical lineages differentially reach their range limits
   b. Phylogenetic diversity is expected to be low in the Chihuahuan Desert relative to the Gulf Coast
   c. The diversity of environmental gradients and substrates in the region, in concert with the region’s position as a biogeographic crossroads, is expected to drive extreme species richness
Hypotheses relating to the biodiversity of Oklahoma and Texas

2. Vegetation responses to climate change in the south-central U.S. will be dramatic and species-specific

3. Species distribution models for plants in the South-Central U.S. that incorporate substrate information, or that are based solely on substrate, will outperform models based solely on climatic data (edaphic heterogeneity hypothesis)
Broader impacts: community engagement

We will engage statewide nonprofit organizations that focus on plants and nature: Master Naturalists, Master Gardeners, and native plant societies.

Members of these organizations will be incentivized by: inherent interest in native plants; required to perform a specified number of volunteer hours for certification; direct engagement with researchers and institutions; individual and group acknowledgment within organizations; digital achievement badges; and activities for mobility-limited members.

Higher rates of accuracy in data transcription and georeferencing than normal can be expected from the members of these groups.
Broader impacts: community engagement

BRIT has engaged these three Texas plant enthusiast organizations through various field and herbarium activities, including label transcription, which will serve as the model for the project.

We will use the Notes from Nature interface, which will include a tracking module for statistics so individual and chapter productivity can be compared.

Some members will be invited to annual TORCH meetings.
Broader impacts: student education and training

20 students will participate in five 10-week Digitization Internship sessions, four interns per Lead.

Interns will be assigned a set of area- or taxon-based specimen datasets to transcribe and georeference and then build a project based on their entered data, the results of which will be presented at TORCH meetings each August.

Onsite or online lectures and workshops by Senior Personnel will comprise ca. 30% of their internship.

Student digitization technicians will be invited to attend these lectures and workshops.

iDigBio Education and Outreach division: open invitation (plea) to advise and contribute.
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Integrated Digitized Biocollections

Lead and Subaward PIs

TORCH, especially co-founders Amanda Neill and Wayne Elisens
Other aspects of the region

Southerly location in the contiguous U.S.; only indirectly affected by Pleistocene glaciation

Phylogenetic and biogeographic history involving four major floristic provinces