History and Computerization of the Kent State University Herbarium[1]

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ABSTRACT. **Herbarium specimens are useful resources in documenting the botanical component of the earth's biological diversity. The Kent State University Herbarium (KE) contains 63,000 specimens of vascular plants. Ohio specimens, most collected since 1960, constitute 80% of the total. The herbarium is currently being computerized in order to facilitate retrieval of information from the specimens and from their labels and to realize other advantages in herbarium-related work. Specimen data are being stored in a computer information retrieval system using dBASE III PLUS. The data are assembled in individual family database files, each file record comprising 24 fields of information. A program has been designed so that the printout of the fields resembles an herbarium specimen label. At present, data for all the pteridophytes, gymnosperms, and monocotyledons have been entered into 63 family files. When computerization of the dicotyledons is completed later in the decade, the database will consist of ca. 220 family files. The database provides an itemized inventory of the collection as well as ready, organized data for a variety of research areas, especially those focused on environmental change and on the preservation of biological diversity.**

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INTRODUCTION AND HISTORICAL CONTEXT

An herbarium is a research museum composed of preserved plant specimens. Typically, specimens of vascular plants are pressed and dried, and then glued to paper.

Each herbarium sheet (Figs. 1,2) consists of one or more plant *specimens* and a *label*. The label records some or all of the following information: scientific name of the plant and the author of that name, notation of the frequency of the plant's occurrence, description of the habitat in which the plant was growing, statement of the location where the plant was collected, description of some of the plant's morphological features, name of the collector, collection number assigned to the specimen by the collector, and the date of collection. The *name of the herbarium* and the *herbarium accession number* and, in some cases, *annotations* (changes in, or confirmations of, the scientific name) appear elsewhere on the sheet. The specimens are filed in herbarium cases according to a taxonomic scheme or in alphabetical order by groups, e.g., family, genus, and species.

Herbarium specimens are most frequently used to document plant distribution. An herbarium specimen provides tangible evidence that a particular plant was growing in a particular place at a particular time. Each specimen is thus a singular historical and botanical entity, documenting a part of the earth's flora.

Specimens may also be used in: 1) nomenclatural work, in which they serve as nomenclatural types, necessary in establishing the correct scientific name of a taxon; 2) monographic and revisionary studies, in which comprehensive classification systems are constructed for particular groups of plants; 3) phylogenetic studies, in which evolutionary relationships of plant groups are established; and 4) identification work, in which specimens already identified serve as references in determining the identity of unknowns (Jones and Luchsinger 1986).

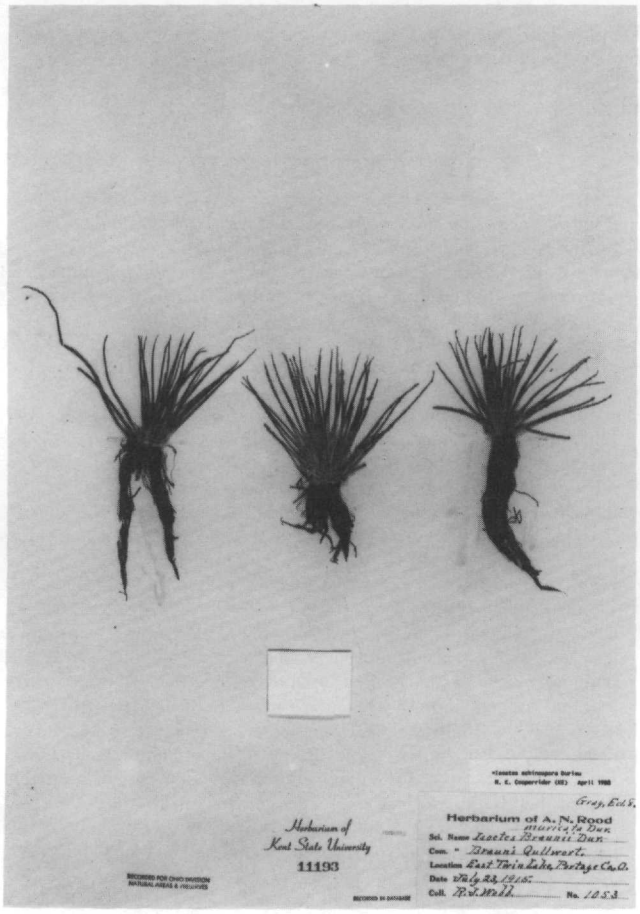

FIGURE 1. Early 20th century Ohio specimen, pteridophyte.

The systematic preparation of herbarium specimens for scientific use began during the Renaissance in 16th century Europe, and the earliest extant specimens date from the same era (Arber 1953). The world's three oldest institutional herbaria were founded during the latter part of that century at the Kassel Naturkundemuseum (Germany) in 1569, the University of Bologna (Italy) in 1570,

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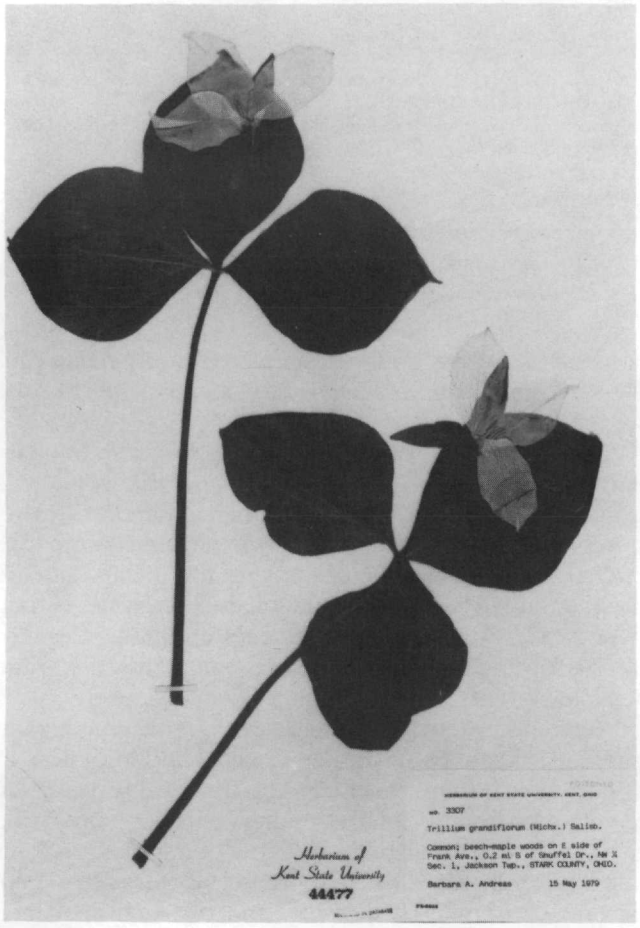

FIGURE 2. Recent Ohio specimen, monocotyledon.

and Basel University (Switzerland) in 1588. The oldest U.S. herbarium, at Salem College, Winston-Salem, NC, was established in 1771 (Holmgren et al. 1990).

As the value of herbarium specimens in understanding the earth's flora became increasingly evident, herbaria became a part of most of the world's scientific research centers. The largest herbarium today, with 8.9 million specimens, is at the National Museum of Natural History in Paris (France). The three largest U.S. herbaria are: New York Botanical Garden, 5.3 million specimens; Harvard University, 4.9 million; and the Smithsonian Institution (U.S. National Herbarium), 4.4 million. In all, there are 628 herbaria in the United States with a combined total of 60.4 million specimens (Holmgren et al. 1990).

Sixteen Ohio institutions have herbaria listed in the most recent edition of *Index Herbariorum* (Holmgren et al. 1990). The oldest is that of the Lloyd Library and Museum in Cincinnati, founded in 1864; the second oldest is that of Ohio Wesleyan University in Delaware, founded in 1870. The four largest Ohio herbaria listed are those at The Ohio State University, with 500,000 specimens; Miami University, with 275,000 specimens; The University of Cincinnati, with 125,000 specimens; and Kent State University, described below. In addition, several small Ohio herbaria not in the *Index* are listed by Cusick and Snider (1984). Together, the state's herbaria house more than 300,000 specimens of vascular plants collected from Ohio; these specimens provide the basic documentation of the state's flora (Cooperrider 1984, 1992).

During the 1970s, the idea of computerization of herbarium collections gradually gained momentum (Macrander and Haynes 1990). Recently a few U.S. herbaria have begun the task of data entry, e.g., University of Alabama and associated universities in southeastern United States (Macrander and Haynes 1990), University of Alaska (Anonymous 1989), and University of California at Berkeley (Duncan 1992). Two notable computerization projects outside the United States are those at the herbaria in Pretoria, South Africa (Gibbs Russell and Arnold 1989), and in Queensland, Australia (Johnson 1991). The trend of storing herbarium specimen data in information retrieval systems will likely accelerate in the 21st century as the need for such information increases in the research of plant systematists, plant geographers, plant ecologists, and conservation and environmental biologists dealing with the study and preservation of biological diversity.

The purpose of the present paper is to describe the history of the Kent State University Herbarium, and the computerization program currently under way.

KENT STATE UNIVERSITY HERBARIUM

History

The Kent State University Herbarium (KE) was founded in 1921. At the end of the 1950s, it contained "about 1500" specimens (Lanjouw and Stafleu 1959). In 1958, T. S. Cooperrider assumed direction of the herbarium; M. K. Cooperrider has managed the collection since 1967. By the mid 1970s KE had grown sufficiently in size and stature to be designated a "National Resource Collection," one of 105 in the nation, in a survey of the systematic botany resources in America conducted by the American Society of Plant Taxonomists (1974).

At the time of this writing, KE has 52,929 accessioned specimens of vascular plants and approximately 10,000 unmounted ones now being processed into the permanent collection. Of these, 80%, ca. 50,000 specimens, were collected from Ohio—the large majority since 1960. The Ohio collections at KE are from six primary sources. 1) Approximately 6,000 specimens were collected by T. S. Cooperrider, mostly from northeastern Ohio in the 1960s. 2) Approximately 3,000 specimens, constituting the private herbarium of the late Almon N. Rood, were acquired in 1962. Rood collected from northeastern counties in the late 19th and early 20th centuries (Cooperrider and Hobbs 1978). This acquisition also included specimens collected from the same region by Rood's contemporaries (Fig. 1). 3) Between 1965-1972, ca. 4,000 specimens, collected during those years from north-central counties, were purchased from George T. Jones of Oberlin College. 4) Since 1960, some 30,000 specimens from throughout eastern and parts of western Ohio have been collected by Kent State University graduate students as a part of floristic, field research projects (Amann 1961, Anderson 1969, Andreas 1980 [Fig. 2], Bradt-Barnhart 1987, Burns 1980, Cline 1977, Cook 1988, Cusick 1967, Emmitt 1981, Hawver 1961, Pusey 1976, Silberhorn 1970, Tandy 1976, Van Natta 1990, Wilson 1972). This group of specimens also includes collections made in support of two major

reports of regional Ohio floras published by KSU graduates, Andreas (1989) and Cusick and Silberhorn (1977). 5) During the past decade, approximately 3,000 recently collected specimens from nature preserves and other natural areas throughout the state have been deposited in KE by staff members of the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, and by staff members of the Ohio Chapter of The Nature Conservancy. Chief among this group are the collections of Allison W. Cusick, of the former agency. 6) Many miscellaneous small groups compose the balance of the Ohio holdings.

Computerization

By the 1980s, hardware and software in personal computers had become sufficiently powerful and affordable to make feasible the general use of computers as an aid to managers of small herbaria with limited staff and budget. Work toward computerization of the KE collection began in 1986, under the direction of M. K. Cooperrider. Because no established models for computerization of herbarium collections were available, the decision on the choice of software was made independently. For KE, dBASE III PLUS was selected because of its reliability and because of its capacity to handle and maneuver large amounts of information. After many programming efforts, this business-oriented database was adapted to herbarium computerization.

The structure and programs were designed to achieve several basic objectives: 1) to enter the label information in such a way that when the record is displayed on the computer screen or in print, the display (Figs. 3,4) closely resembles a specimen label; 2) to enter any annotation information on the herbarium sheet, as well as an indication of the reproductive status (e.g., flowering or fruiting) of the specimen; and 3) to develop the database so that the fields can easily be listed, alphabetized, counted, put into numerical order and/or into collection date sequences. This system provides most of the information needed by researchers.

ISOETACEAE
Isoetes echinospora Durieu

ORIGINAL ID: Isoetes braunii Dur. ANNO: Isoetes muricata Dur., A N Rood, no date; =I. echinospora Durieu, M K Cooperrider (KE), April 1988; recorded for Ohio Division Natural Areas & Preserves, no date

US OH PORTAGE COUNTY
East Twin Lake. A N Rood Collection #1053.

R J Webb 23 July 1915
KE 11193 REPRODUCTIVE STATUS = F

FIGURE 3. Printout of record for specimen shown in Fig. 1.

The resulting database record consists of 24 separate information areas or fields per specimen (Table 1). Each field can be manipulated independently or in combination with other fields. For example, data can be printed in list form for any one field or any group of fields.

In order to speed access to the stored data, an individual file was established for each plant family. The file name consists of the first eight letters of the family name plus the extension "DBF" (database file), e.g., EQUISETA.DBF for the Equisetaceae.

LILIACEAE
Trillium grandiflorum (Michaux) Salisb.

US OH STARK COUNTY
Common; beech-maple woods on E side of Frank Ave, 0.2 mi S of Shuffel Dr, NW 1/4 Sect 1, Jackson Twp.

B A Andreas 3307 15 May 1979
KE 44477 REPRODUCTIVE STATUS = FL

FIGURE 4. Printout of record for specimen shown in Fig. 2.

The procedures for data entry are these. Preliminary entries are made in temporary files on diskettes and a printout produced. With the specimen at hand, the printout is checked for accuracy. Any necessary corrections are made on the temporary file, and the edited data are then appended to the family file on the hard drive. A hard copy and backups on other diskettes are made. Because dBASE does exact field searches, standardization and accuracy of entry in all fields are checked closely.

A computer database offers several advantages over traditional methods of retrieving and handling information from herbarium sheets. 1) The database serves as an annotated inventory of the entire collection, providing ready access to all or selected items of information. This information includes data otherwise inaccessible except by time-consuming search for, and of, each specimen sheet. These data are of special value in making available information on significant specimens located in small herbaria, specimens that might otherwise be overlooked in a general survey of a particular taxon. 2) The database provides a copy of the information on the herbarium sheets. This backup record is invaluable in cases of specimen misplacement or loss. 3) Use of the database reduces researcher handling of the specimens, which are inherently fragile. In some instances, such as preliminary surveys, it may obviate the need for any handling of specimens. 4) The database facilitates management of specimen loans to researchers at other institutions. For both parties to the loan, verification of the specimens involved is more precise. Concurrent receipt of a data printout with the loaned specimens expedites the researcher's work. 5) If necessary, new labels can be generated from the database to replace or supplement the originals. This can be valuable in instances where either the writing on the label or the label paper itself is deteriorating. 6) As a result of the typists' increased familiarity with an individual botanist's writing style, additions can be entered into the database that provide an elaboration of data not otherwise available, e.g., full surname of the collector(s) and especially of the annotator(s) represented only by an initial, full spelling of location terms represented by abbreviations, a complete date—especially the correct century—represented on the label by a condensed date, and a general deciphering of old handwritten labels. 7) The database makes possible the generation of an account, in historical sequence, of the work of an individual collector or of the collections from

TABLE 1

Kent State University Herbarium database structure.

Field No.	Field Name	Entry Type	Length of field, bytes	Remarks
1	GROUP	Character	1	Major plant group, e.g., M for monocotyledons
2	FAMILY	Character	17	Scientific name of family
3	GENUS	Character	16	Scientific name of genus
4	SPECIES	Character	17	Specific epithet
5	AUTHOR	Character	37	Author(s) of species name
6	SSPVAR	Character	20	Infraspecific epithet
7	SSPAUTHOR	Character	35	Author(s) of infraspecific epithet
8	ANNOTATION	Character	240	Annotation(s)
9	COUNTRY	Character	2	Abbreviation of name
10	STATE	Character	2	Abbreviation of name
11	COUNTY	Character	15	Name of county
12	QUAD	Character	18	Name of topographic quadrangle
13	DESCRIPT	Character	254	Narrative data on label
14	FNAME	Character	3	Collector's first and middle initials
15	LNAME	Character	13	Collector's surname
16	CNUMB	Numeric	5	Collection number
17	CNS	Character	1	Collection number suffix, e.g., 4167*A*
18	ADDCOLL	Character	26	Name of additional collector(s)
19	COLLDATE	Date	8	Collection date
20	HERB	Character	5	Herbarium acronym
21	HERBNO	Numeric	7	Herbarium accession number
22	SUFFIX	Character	1	Accession number suffix, e.g., 54639*B*
23	REPROSTAT	Character	5	Flowering (FL), fruiting (FR), fertile (F), or vegetative (V)
24	ENDANGERED	Character	1	Endangered status, abbreviated

a particular county or a particular natural area.

The critical examination of each herbarium sheet during the data entry process yields secondary benefits. A comparison to data already entered from other specimens of a given collector may allow for the correction in the database of misspelled or illegible words on the label or for the completion of partial or missing information, such as an incomplete location or a missing collection date. The data entry process also provides opportunity for standardization of all abbreviations, e.g., the names of authors of scientific names and the common terms used in reporting locations. As a result, the information in the database may be more thorough and more easily understood than that on the herbarium sheets themselves. In addition standard curatorial problems, such as misplaced specimens and specimens needing repair, are brought to light during the inventory process.

Computerization at KE is now complete for the pteridophytes (ferns and "fern allies"), gymnosperms, and monocotyledons. The database for these groups comprises 63 family files that represent 26% of the total mounted collection. When computerization of the dicotyledons is completed later in the present decade, the database will consist of ca. 220 family files. Three separate database files, each with a unique structure, are used for hybrid, foreign (non-U.S.), and cultivated plant specimens. Newly mounted specimens of the completed groups are now routinely computerized as part of the accessioning process.

The present records are compatible with dBASE IV. Upgrade of the software to dBASE IV is planned for a later date, at which time relational database files can be created and new programs written.

The size of the KE collection makes computerization feasible. The unique nature of the collection, consisting chiefly of contemporary records of Ohio vascular plants, makes the project of more than usual value in understanding the structure of the Ohio flora as it exists today and the structure of this portion of the earth's biological diversity.

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LITERATURE CITED

Amann, J. E. 1961 A survey of the vascular plants of Stark County, Ohio. M.A. Thesis, Kent State Univ., Kent, OH. 230 pp.

American Society of Plant Taxonomists, Advisory Committee for Systematic Resources in Botany 1974 Systematic Botany Resources in America, Part 1. New York Botanical Garden, New York, NY. 88 pp.

Anderson, S. M. 1969 The vascular plant flora of Medina County, Ohio. M.A. Thesis, Kent State Univ., Kent, OH. 92 pp.

Andreas, B. K. 1980 The flora of Portage, Stark, Summit and Wayne Counties, Ohio. Ph.D. Dissertation, Kent State Univ., Kent, OH. 680 pp.

_____ 1989 The vascular flora of the glaciated Allegheny Plateau region of Ohio. Ohio Biol. Surv. Bull. N.S. 8(1). 191 pp.

Anonymous 1989 News from herbaria: ALA. Herbarium News 9: 33.

Arber, A. 1953 Herbals, Their Origin and Evolution: A Chapter in the History of Botany, 1470-1670. 2nd Ed. Cambridge University Press, Great Britain. 326 pp.

Bradt-Barnhart, J. S. 1987 A floristic survey of the vascular plants of Little Mountain and other peaks in northeastern Ohio. M.S. Thesis, Kent State Univ., Kent, OH. 152 pp.

Burns, J. F. 1980 The flora of Trumbull County, Ohio. M.S. Thesis, Kent State Univ., Kent, OH. 197 pp.

Cline, R. J. 1977 The vascular plants of Perry County, Ohio. M.S. Thesis, Kent State Univ., Kent, OH. 201 pp.

Cook, T. E. 1988 The flora of four natural areas of northwestern Ohio. M.S. Thesis, Kent State Univ., Kent, OH. 122 pp.

Cooperrider, T. S. 1984 Ohio's herbaria and the Ohio Flora Project. Ohio J. Sci. 84: 189-196.

_____ 1992 Changes in knowledge of the vascular plant flora of Ohio, 1860-1991. Ohio J. Sci. 92: 73-76.

_____ and C. H. Hobbs 1978 Almon Rood: The Western Reserve's botanist. Western Reserve Magazine 5(5): 18-20, 50-52.

Cusick, A. W. 1967 The vascular plants of Jefferson County, Ohio. M.A. Thesis, Kent State Univ., Kent, OH. 226 pp.

_____ and G. M. Silberhorn 1977 The vascular plants of unglaciated Ohio. Ohio Biol. Surv. Bull. N.S. 5(4). 153 pp.

_____ and J. A. Snider 1984 Survey of the herbarium resources of Ohio. Ohio J. Sci. 84: 175-188.

Duncan, T. 1992 Collections computerization at the University of California. Am. J. Bot. 79(Abstracts): 146.

Emmitt, D. P. 1981 The vascular plants of Ashland County, Ohio. M.S. Thesis, Kent State Univ., Kent, OH. 276 pp.

Gibbs Russell, G. E. and T. H. Arnold 1989 Fifteen years with the computer: Assessment of the "PRECIS" taxonomic system. Taxon 38: 178-195.

Hawver, W. D. 1961 The vascular flora of Geauga County, Ohio. M.A. Thesis, Kent State Univ., Kent, OH. 94 pp.

Holmgren, P. K., N. H. Holmgren, and L. C. Barnett (Eds.) 1990 Index Herbariorum. Part I: The Herbaria of the World. 8th Ed. New York Botanical Garden, Bronx, NY. 693 pp.

Johnson, R. W. 1991 HERBRECS—the Queensland Herbarium records system—its development and use. Taxon 40: 285-300.

Jones, S. B., Jr. and A. E. Luchsinger 1986 Plant Systematics. 2nd Ed. McGraw-Hill, New York, NY. 512 pp.

Lanjouw, J. and F. A. Stafleu 1959 Index Herbariorum. Part I. The Herbaria of the World. 4th Ed. International Association for Plant Taxonomy, Utrecht, Netherlands. 249 pp.

Macrander, A. M. and R. R. Haynes 1990 SERFIS: A methodology for making multi-herbaria specimen databases a reality. Taxon 39: 433-441.

Pusey, P. L. 1976 The vascular plants of Knox County, Ohio. M.A. Thesis, Kent State Univ., Kent, OH. 221 pp.

Silberhorn, G. M. 1970 The flora of the unglaciated Allegheny Plateau of southeastern Ohio. Ph.D. Dissertation, Kent State Univ., Kent, OH. 371 pp.

Tandy, L. W. 1976 Vascular plants of four natural areas of northeastern Ohio. M.S. Thesis, Kent State Univ., Kent, OH. 140 pp.

Van Natta, P. L. W. 1990 Survey of vascular plants in selected natural areas on the Lake Plain in Lake and Ashtabula Counties, Ohio. M.S. Thesis, Kent State Univ., Kent, OH. 354 pp.

Wilson, H. D. 1972 The vascular plants of Holmes County, Ohio. M.A. Thesis, Kent State Univ., Kent, OH. 273 pp.