FINAL REPORT

1999 Project Abstract
For the Period Ending June 30, 2001

Title: B22 Improved Minnesota Fungus Collection and Database
Project Manager: David J. McLaughlin
Organization: University of Minnesota
Address: Herbarium, University of Minnesota, 220 Biological Sciences Center, 1445 Gortner Ave., St. Paul, MN 55108-1095
Web Site Address: http://fungi.umn.edu
Fund: LCMR Trust Fund
Legal Citation: ML 1999, Chap. 231, Sec. 16, Subd. 12(j)

Appropriation Amount: $70,000

Overall Project Outcome and Results: A centralized database for the fungi of Minnesota has been produced as a result of consolidation of the two University of Minnesota fungal collections. It is accessible at http://fungi.umn.edu or http://www.fungi.umn.edu. This database provides information on the distribution, ecology, and history of the fungi of the state for use in agriculture, forestry, and recreation management. The web site includes a non-technical general introduction to the fungi, illustrations of mushrooms and plant pathogens, a history of the collection and the state of knowledge of the fungi of Minnesota, and a taxonomic outline for the specialist. The database is searchable in multiple ways, including by plant host and habitat, and it can produce reports that can be sorted by up to three fields.

We processed and moved approximately 45,000 specimens from the Dept. of Plant Pathology to new herbarium cases in the University of Minnesota Herbarium. A dedicated computer with the software program "Specify" for data entry was set up, and 6700 Minnesota fungal specimens have been entered into the database. Six of seven cases of Minnesota fungi have been processed into archival mounting for long term preservation. Entry of the remaining specimen data and specimen processing is continuing. Consolidation of the fungal collections has multiple benefits, including assisting in obtaining fungi for research in the state, fungal identification, and teaching.

Project Results Use and Dissemination: The new database is also accessible through the Bell Museum of Natural History and University of Minnesota web sites. It was used at the North American Mycological Society of America meeting in Collegeville, July 5-8, to

find sites for mushroom collection. The database will be advertised to professional mycologists in *Inoculum*, the newsletter of the Mycological Society of America.

Date of Report: July 1, 2001
LCMR Final Work Program Report
Date of Workprogram Approval: June 16, 1999
Project Completion Date: June 30, 2001

1. Project Title: B22 Improved Minnesota Fungus Collection and Database

Project Manager: David J. McLaughlin
Affiliation: University of Minnesota
Mailing Address: Herbarium, University of Minnesota, 220 Biological Sciences Center, 1445 Gortner Ave., St. Paul, MN 55108-1095
Telephone number: 612-625-5736
E-Mail: davem@tc.umn.edu
Fax: 612-625-1738

Total Biennial Project Budget:

$ LCMR: 70,000

= $LCMR Balance: 0

A. Legal Citation: ML 1999, Chap. 231, Sec. 16, Subd. 12(j).
B22 Improved Fungus Collection and Database

Appropriation Language: Improved Minnesota Fungus Collection and Database $35,000 the first year and $35.000 the second year are from the trust fund to the University of Minnesota to consolidate and preserve fungus specimen collections and computerize the data for use in agriculture, forestry and recreation management.

B. Status of Match Requirement: Not applicable.

II. and III. Final Project Summary:

Overall Project Outcome and Results: A centralized database for the fungi of Minnesota has been produced as a result of consolidation of the two University of Minnesota fungal collections. It is accessible at **http://fungi.umn.edu** or **http://www.fungi.umn.edu.** This database provides information on the distribution, ecology, and history of the fungi of the state for use in agriculture, forestry, and recreation management. The web site includes a non-technical general introduction to the fungi, illustrations of mushrooms and plant pathogens, a history of the collection and the state of knowledge of the fungi of Minnesota, and a taxonomic outline for the specialist. The database is searchable in multiple ways, including by plant host and habitat, and it can produce reports that can be sorted by up to three fields.

We processed and moved approximately 45,000 specimens from the Dept. of Plant Pathology to new herbarium cases in the University of Minnesota Herbarium. A dedicated computer with the software program "Specify" for data entry was set up, and 6700 Minnesota fungal specimens have been entered into the database. Six of seven cases of Minnesota fungi have been processed into archival mounting for long term preservation. Entry of the remaining specimen data and specimen processing is continuing. Consolidation of the fungal collections has multiple benefits, including assisting in obtaining fungi for research in the state, fungal identification, and teaching.

Project Results Use and Dissemination: The new database is also accessible through the Bell Museum of Natural History and University of Minnesota web sites. It was used at the North American Mycological Society of America meeting in Collegeville, July 5-8, to

find sites for mushroom collection. The database will be advertised to professional mycologists in *Inoculum*, the newsletter of the Mycological Society of America.

IV. Outline of Project Results:

Result 1: Process and move 45,000 specimens from Dept. of Plant Pathology to herbarium cases in the University of Minnesota Herbarium. Specimens of Minnesota fungi were moved first so that remounting and data entry could begin. In addition, written records on the collections were moved and organized to aid in data entry. All specimens are now located in one place, which makes using them simpler and more efficient. Processing them through the freezer has eliminated insect pests that destroy the specimens. Storage in modern metal cabinets protects them from damage by insects, water, or other agents. Photographs of fungi in the collection have also been moved for later analysis and use.

The budgetary constraint that permitted spending only half of the budget in the first year caused a delay in obtaining new cabinets. The delay lead to insufficient space to store specimens in the University Herbarium after processing through the freezer. The specimens had to be returned to the Plant Pathology Herbarium in sealed plastic bags for temporary storage until space became available. This slowed the movement of specimens and required extra time.

LCMR Budget: $22,993
Balance 0

Result 2: Decide on and purchase computer hardware and software; write program. A dedicated computer and printer have been set up to handle the fungal collection. The software program "Specify", developed by the National Science Foundation for managing museum collections, became available in fall, 1999 and has been used to build the database. Because the program is new, there have been many problems, and we have worked closely with a programmer at the University of Kansas to solve them. University of Minnesota programmers moved our fungal "Rbase" database into "Access" and set up fields for the data conversion to "Specify". It took several months to edit ca. 4000 records in "Access"and some problems, such as species authorities and geographic information, have not been fully resolved; these will need to be edited record by record in the future. The "Access" database was combined with our "Specify" database by the University of Kansas programmer, who also developed a herbarium label form needed to label remounted specimens. The taxonomic tree needed for correct data entry was disrupted when the databases were combined; approx. 10 days were required to reconstruct the tree. Considerable difficulty was also encountered in getting the label program to function consistently. The "Specify" project is also to supply additional label forms, and loan and report forms for use with the database. "Specify" is being developed to provide major analytical capabilities. It is being used in all Bell Museum collections. We expect that the fungal database will be an important research tool when "Specify" is fully developed.

LCMR Budget: $ 9,718
Balance 0

Result 3: Computerize and remount as needed ca. 10,000 specimens of Minnesota fungi; integrate 45,000 Plant Pathology specimens with 50,000 Herbarium fungal specimens. In preparation for filing the specimens moved from Plant Pathology, 21 cases of fungal specimens in the main herbarium were checked for Minnesota fungi needing computerization, and many collections improperly filed geographically were refiled. In the process many type collections of plant pathogens (rust fungi) were located and moved for later entry into the database. Specimens in poor condition have been remounted or marked for later remounting.

Of the seven cases of Minnesota fungi moved from Plant Pathology, specimens in five cases have been remounted, computerized and are mostly filed, those in one case await computerization, and in the other case await both remounting and computerization. The database now contains 6700 specimens and 2800 specimens need computerization. Data entry was slowed down, because of the problems encountered in Result 2, i.e., problems with editing the fungal "Rbase" file in "Access", with the combined database, and with the labeling program. The rate of data entry has been much slower with "Specify" than with our previous program, and many more taxonomic problems have been encountered with the older specimens. Data entry and processing will continue but not on LCMR funds.

Integration of the remaining Plant Pathology specimens with the specimens in the Herbarium has begun but will take considerable time to complete. Integration involves checking specimen quality, assigning an accession number, taxonomic and geographic placement, and filing in existing or new genus folders. These specimens, although not integrated into the collection are accessible for study as they have been filed alphabetically.

A graduate student filled the data entry position for both years. This was a modification of the original plan, which was for a graduate student assistant for only one year, and was necessitated by the demand for considerable expertise in checking specimen quality, determining current specimen name or identify, and updating geographic information.

LCMR Budget: $32,709
Balance 0

Result 4: Link to existing web site for vascular plants and run summary analysis. More has been done with the web site than was originally proposed. The web site is now up and functioning at http://fungi.umn.edu or http://www.fungi.umn.edu. The web site will be updated constantly as new data is added.

The web site includes a non-technical general introduction to the fungi with illustrations of mushrooms and plant pathogenic fungi to demonstrate the capabilities of the database for those unfamiliar with fungi. The Photo Gallery provides illustrations with links to the specimens in the database for 1) the state mushroom, 2) fungi on "Minnesota's List of Endangered, Threatened, and Special Concern Species", 3) plant pathogenic fungi, and 4) mushrooms, including the beginning of an illustrated list for the Long Term Ecological Research site at Cedar Creek Natural History Area in Anoka and Isanti counties, as well as of mushrooms in Minnesota in general. The page describing the history of the collection also includes a summary of the state of knowledge of the fungi of Minnesota, so that the limitations in our knowledge of fungi in the state can be readily grasped and study of the fungi may be promoted. Another page provides a taxonomic outline for the specialist with reference to current literature on fungi. Space has been provided for a news section, and planned additions to the web site, including literature on Minnesota fungi and on the type collection.

A web program for "Specify" was expected in fall, 2000 but was not available by early 2001, so the University programmers modeled the web site on the existing University Herbarium web site. Modifications to the design were needed because of the special requirements of the fungal database, i.e., a need to be able to search by fungal host or substrate, as well as by species. The database is searchable in multiple ways, including by plant host and habitat, and it can produce reports that can be sorted by up to three fields that can be changed in many different combinations. Summary analyses of the pathogenic and non-pathogenic fungi in the database have been run by the two scientists involved in the project, and successful retrieval of records using a variety of queries has been obtained.

LCMR Budget: $4580
Balance 0

V. Dissemination: The fungal database utilized the "Specify" program for museum collections that is being developed at the University of Kansas with support from the National Science Foundation. The fungal database at http://fungi.umn.edu or http://www.fungi.umn.edu is linked to the web pages of the Bell Museum of Natural History (http://www1.umn.edu/bellmuse/collections.html) and the University Herbarium (http://biosci.cbs.umn.edu/herbarium/).

VI. Context:

A. Significance: The objectives are to integrate the two fungal collections at the University of Minnesota and to provide a computerized database for the Minnesota specimens. The computerized data will contain all the label data on the specimens. These data can be sorted and retrieved in various ways: by species, geographic locality, management unit, habitat, host plant species, collector, etc., and thus provide readily accessible summary information on the fungi of Minnesota. Distribution maps for each species will be obtainable with future versions of "Specify".

Fungi are an integral component of natural and managed ecosystems important for agriculture, forestry, wildlife, urban landscapes and recreation. They include a broad range of organisms: mushrooms, puffballs, cup fungi, including the morel, the Minnesota State Mushroom, slime molds, plant diseases, such as rusts, smuts, and wheat scab, and decomposers and wood decay fungi, such as shelf and bracket fungi. Some mushroom species are mutualists important for the health of forest trees.

The University of Minnesota Herbarium, a unit of the Bell Museum of Natural History, has been the official repository for botanical specimens since 1890. The fungal collection was split about 75 years ago, part moving to St. Paul for use in plant pathology and the rest remaining in the Herbarium in Minneapolis for floristic studies. This arrangement has complicated access to fungus collections in Minnesota. With the move of the Herbarium to St. Paul, the two fungal collections were now housed in adjacent buildings. The two collections contain approx. 95,000 specimens. The approx. 10,000 Minnesota specimens contain the primary record of the fungi of Minnesota. These specimens have label data that includes species name, geographic origin, date of collection, collector, ecological data, and some are accompanied by descriptions of the fungi, and photographic or microscope slides. These specimens are essentially the only source of primary information on most fungi in the state.

With the threat of global climate change, the relatively limited remaining pre-European settlement vegetation, and pressures from invasive organisms (plants, animals, other fungi), it is important to document the present biodiversity of the state. This effort will be greatly enhanced when the two collections are combined and computerized and the number of known species and their geographic distribution within the state can be determined. Because fungi are identified from their fruiting structures, which for many appear sporadically, they have proven more difficult to catalogue than vascular plants. A conservative estimate of the number of fungi in Minnesota can be made based on the 1600 native vascular plants. We expect ca. 9000 fungal species, and we estimate that 2-3000 species are presently documented. An exact number based on the specimens is difficult to obtain until the collections are integrated. Other benefits of computerization include use of a single filing system that will serve the needs of those requiring information on specialized or broader fungal groups, and reduction in wear and tear on the specimens in obtaining information.

Before the start of this project, a computer database for the fungi in the Minnesota Herbarium was developed using Rbase 3.1 and about 2300 specimens computerized. This database needed to be upgraded and modified for internet access. It needed to be linked to the Herbarium web site for the vascular plants to provide access for plant pathologists, forestry personnel, parks and recreation personnel, biologists and others with use for the data within the state. It will also provide nationwide access for those with similar interests or carrying out systematic or biogeographic studies. Two examples of its expected use in

Minnesota by the USDA Cereal Disease Laboratory, St. Paul, are to find specimens needed for the study of the evolution of rust fungi in relation to the plant hosts that they parasitize, and to search for fungi on corn stalks and small grain straw that compete with *Fusarium graminearum*, the cause of Fusarium head blight of wheat and barley, on these substrates.

The fungal database will utilize the "Specify" program being developed at the University of Kansas with support from the National Science Foundation. This program is designed for use by all collections within a museum, whether they are animal, plant or fungi. This program will make data maintenance and upgrading for the entire museum collection much simpler and more efficient. First release of the "Specify" program was projected for Nov. 1998.

Collection needs: The specimens to be added to the Herbarium collection needed archival quality cases (many of the present cases were wood). A modern and dedicated computer and software were needed to replace outmoded ones. Aprox. half of the specimens of Minnesota fungi required archival quality mounting.

B. Time: Two years.

C. Budget Context: 1. LCMR Budget History: $130,000, 1991-1993, A computerized database for the plants of Minnesota; $51,000, 1993-1995, Description and evaluation of Minnesota old-growth forests, C. Characterization of the ectotrophic mycorrhizal fungi in old-growth forest types.

2. Non-LCMR Budget History: $2-3000/year, Dept. of Plant Biology/Bell Museum, for Herbarium student help and supplies; $3500 for 2 years, Dept. of Plant Pathology, to organize and upgrade collections; $ 4000, 1996-1997, Minnesota DNR Natural Heritage and Nongame Research Program, to complete study of ectotrophic mycorrhizal fungi of Minnesota's young and old-growth northern hardwood conifer and red pine forests; $ 3595, 1998, Minnesota DNR Natural Heritage and Nongame Research Program, for the project, A search for three rare, endemic Minnesota mushroom species.

1.

BUDGET:

Personnel	David J. McLaughlin, Project Director, 25 % time	
	Curatorial Assistant (graduate student) 50 % time, 12 mo. (data entry, supervise mounting, filing) Salary, 13780; Fringe benefits 8268	$24,576
	Student assistant, 260 hr, 7.50/hr. (process and move specimens)	$1,950
	Student assistant, 780 hr., 7.50/hr. (remount and label specimens)	$5,850

Cooperators: James V. Groth, Professor, Dept. of Plant Pathology, University of Minnesota, St. Paul

Kurt Leonard, Research Leader, Cereal Disease Laboratory, USDA, St. Paul.

Equipment	Herbarium cases (26), shipping and set up	$20,979
	Dedicated database computer, collections database software	4000
Other		
Office supplies		
	Mounting materials, label paper, print cartride	$2,283
	Boxes, freezer bags to process/move specimens	64
	Ethernet connection, $ 300, plus 10/mo. rental	$0
	Server setup, update and backup	$460
	Computer programmer	$9838
	(Write forms, transfer data, create Web interface)	
Total		$ 70,000

2. Attachment A. Deliverable Products and Related Budget
(See next page)

ATTACHMENT A (include the attachment in all future update reports.) Use as many results as necessary. Landscaping on legal size paper to fit in all the columns may be helpful.

The commission will not allow office space rental fees or salary payments to officers or directors, this applies to ALL PROJECTS. See page 9 for Eligible and Ineligible expenses.
GENERAL OTHER WILL NOT BE ACCEPTED. BE SPECIFIC AND USE AS MANY LINES AS NECESSARY.

Project Title:Consolidation and Computerization of Mn Fungus Collections

Project Number: 12 J

LCMR Recommended Funding: $

Attachment A Deliverable Products and Related Budget

2001 LCMR Project Biennial Budget

	Objective/ Result														
Current invoice for YTD expenses through December 2000	**Result 1 Budget:**	**Result 1 Current invoice:**	**Result 1 Balance:**	**Result 2 Budget:**	**Result 2 Current Invoice:**	**Result 2 Balance:**	**Result 3:Budget**	**Result 3 Current Invoice:**	**Result 3 Balance:**	**Result 4:Budget**	**Result 4 Current Invoice:**	**Result 4 Balance:**	**PROJECT TOTAL:**		
Budget Item (Title of Result)	**Title Process and Move Specimans**			**Title Computer Purchase and Programming**			**Title Remount specimens/ Integrate Collections**			**Title Remount specimens/ Integrate Collections**			**BUDGET TOTAL:**	**CURRENT INVOICE TOTAL:**	**BALANCE TOTAL:**
Wages, salaries & benefits — Be specific on who is paid $	1,950	1,950	0				27,898	30,285	-2,387				29,848	32,235	-2,387
Change on Wages, salaries & benefits	1,950	1,950	0				30,426	30,285	141				32,376	32,235	141
Contracts													0	0	0
Other direct operating costs: Programming Services				5,718	5,718	0				4,580	4,305	275	10,298	10,023	275
Communications, telephone, mail, etc.				540	0	0							540	0	540
Change on Communications, telephone				0	0	0							0	0	0
Office Supplies (list specific categories)	64	64	0				950	2,598	-1,648				1,014	2,662	-1,648
Change on Office Supplies	64	64	0				2,283	2,598	0				2,347	2,662	-315
Office equipment & computers (be specific)				4,000	4,101	0							4,000	4,101	-101
Other Capital equipment (list specific items) Herbarium Cases	24,300	20,979	3,321										24,300	20,979	3,321
Change on Captital Equipment	20,979	20,979	0										20,979	20,979	0
COLUMN TOTAL	26,314	22,993	3,321	10,258	9,819	439	28,848	32,883	-4,035	4,580	4,305	275	70,000	70,000	0
Change on Column Total	22,993	22,993	0	9,718	9,819	-101	32,709	32,883	-174	4,580	4,305	275			

VII. Cooperation:
James V. Groth curates the plant pathology disease collection in the Dept. of Plant Pathology and will assist in the sorting and transfer of these specimens to the main herbarium; 5% time.
Kurt Leonard will provide guidance on computer needs for cereal disease research and assist in testing the system; 5% time.

VIII. Location: University of Minnesota, St. Paul.

IX. Reporting Requirements: Periodic workprogram progress reports will be submitted not later than Jan. 1, 2000, June 30, 2000, and Jan. 1, 2001.
A final workprogram report and associated products will be submitted by July 1, 2001, or by the completion date as set in the appropriation.