

## **Computerization of mycological collection data of the American Type Culture Collection\***

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The Mycology Department of the ATCC has recognized the need for accessible and up-to-date documentation of its cultures and has begun to computerize strain data and to develop a laboratory information management system to better serve the scientific community and bioindustry. Establishment of a PC-based laboratory management system has had a profound impact on the operation of the Department. Operations are smoother and more efficient, and far more valuable use is now being made of the accumulated strain data. Although not yet networked, all of the personal computers in the Department are compatible. Information can be easily passed among them by means of floppy diskettes. At the present time, the Mycology Department also relies on data resources maintained by other ATCC departments to support its information retrieval needs. The Department is linked by terminal to the Hewlett-Packard minicomputer which contains the Product File record of each fungal culture. A discussion of the current use of computers in the Mycology collection must necessarily include a consideration of computerization throughout the ATCC because of the close interaction among the various departments in the culture collection.

The data associated with strains of microorganisms preserved in culture collections are invaluable for research, teaching, and industry, particularly biotechnology. Rapid advances in science have produced a proliferation of new data accompanied by the increased burden of their storage, retrieval, manipulation, and analysis. The value of the data lies not in how much can be stored, but in how quickly and easily the stored information can be retrieved for use.

In recent years electronic data processing has become an important feature in every phase of the collection activities of the American Type Culture Collection, including acquisition, accessioning, inventory, cataloguing, accounting, order processing, shipping, and quality control. At the present time the ATCC has three minicomputers and 78 personal computers (PC's) with a variety of software. A

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### **Mycology Department**

Since the quality of each fungus culture depends on accurate culture data, a vast amount of paperwork is generated in the day-to-day management activities. In recent years the increased demands of researchers for cultures with certain attributes and new or changing regulations, such as Good Laboratory Practices (GLP) and Good Clinical Practices (GCP), have created a need for accessible and up-to-date documentation on the cultures. At the same time the rapid growth of the literature involving ATCC fungus cultures requires the Mycology Department to constantly upgrade strain data. Automation of strain data and development of a laboratory information management system became a necessity (JONG, 1984).

In developing the system, the Mycology Department sought software which would be easy to:

- (1) use, so that information could be pulled from the stored data and consolidated for reports;
- (2) access and monitor data over time;
- (3) install, minimizing disruption to the laboratory operation;
- (4) learn, affording efficient transition for new staff members; and
- (5) expand or change with the evolution of operations.

Sci-Mate was selected and has been used in the Mycology Department since January 1987 for storing and searching data on new accessions. This software is no longer available, but the ATCC will continue to use it until a satisfactory replacement can be found. At the present time, the Department employs four PC's in its operation and has terminal-access to the Hewlett-Packard 3000 minicomputer (HP) which contains a Product File record on each culture in the Collection.

#### *A. Departmental Office*

The Departmental Secretary relies on an AST Premium 286 Model 80 (IBM AT compatible) microcomputer with a Hewlett-Packard Laserjet Series II printer. The software includes WordPerfect 5.0 for papers, reports, letters, memos, and other typing; Lotus 1-2-3 for spread sheets; and Sci-Mate for the various databases.

## 1. Acquisition and Accession

It is essential that each new culture received by the Department for accession be recorded upon arrival. After it is logged in, the Departmental Secretary can determine whether this culture is one previously requested and/or received by referring to a Sci-Mate database, the **Cultures User File**. If there are any existing records on the deposit, they can be examined and updated; otherwise, a new record is created.

The **Cultures User File** for new mycological accessions has 20 fields in each record. Field headers and mnemonic codes used in searching are:

GENUS	Genus name of the strain (GE=)
SPECIES	Specific epithet of the strain including subspecies, variety, or forma specialis (SP=)
STRAIN	Depositor's strain designation (ST=)
REF	Any published material that mentions the strain (RF=)
DEPOS	Depositor's name (DE=)
LOCATION	Depositor's address (LO=)
DATE REQ	Date culture requested, or state "not requested" (DR=)
DATE REC	Date culture received (RC=)
ATCC NO	ATCC accession number (AN=)
USE	Special applications (US=)
DATE ACC	Date culture accessioned, i.e., given an ATCC number (DA=)
HAND BY	Name of lab employee assigned to handle the culture (HB=)
RET DEP	Date culture returned to depositor to be checked (RD=)
APPROVE	Whether depositor approved of returned culture (AP=)
CATALOGUE	Date folder sent to Publications for cataloguing (CA=)
NUM SENT	Date notification of ATCC number sent to depositor (NS=)
INVENT	Date Publications and Manufacturing Departments are notified to release culture for distribution and the form of availability (IN=)
CLASS	Classification of culture by sporulation characteristics, e.g., Ascomycete, Basidiomycete, Imperfect, etc. (CL=)
TYPE	Whether the culture is a type culture (TY=)

In addition to cards and forms which must be manually typed for each new culture, WordPerfect computer forms are used to request an ATCC accession number from the Publications Department and to prepare the information sheet for subsequent cataloguing. After the number is assigned, it is added to the **Cultures User File** which is updated as each new piece of information becomes available.

The Head of the Department conducts an ongoing review of the scientific literature in the field of mycology and selects new strains of fungi for possible addition to the Collection. Before a request for a culture is made, the names of the investigator and the organism are checked in the **Cultures User File** to avoid duplicate requests. The current catalogue of ATCC fungi/yeasts can be searched through another Sci-Mate database, the **Mycology User File**. By entering the species name and the strain designation, any culture of that strain already in the Collection can be located. If no duplication is found, the appropriate form letter requesting cultures may be generated, and the first seven items on the **Cultures User File** are entered.

## 2. Reporting

Monthly reports depend primarily on the information contained in the **Cultures User File** and are prepared using WordPerfect. The total number of new strains requested, received, received but not accessioned, accessioned, and those pending depositor's approval are easily determined by searching the database.

At the end of each quarter, a list of new fungi which have been released during that period is submitted to the Editor of the ATCC Quarterly Newsletter. Lotus 1-2-3 is utilized in the preparation of the report. In addition, quarterly reports which include lists of accessions by name, reproductive classification, address of depositor, and special application are submitted to the Collection management.

In response to queries from staff members or depositors on the status of an accession, i.e., whether it is in progress, on hold, or available for distribution, the Departmental Secretary may access the comprehensive Product File record on the HP. Moreover, the Department receives a monthly status report generated automatically by the Computer Systems Manager listing accessions with a critically low inventory. The report includes the number of months the culture has been on the list, whether it is a patent culture, and the quantity of any withheld inventory. Any culture which is "on hold" or "in progress" and has not yet been released for distribution will appear on a separate list.

### *B. Research Laboratories*

The research mycologists use an AT&T PC 6300 (IBM XT compatible) personal computer with an EPSON FX286 E printer. In

addition to WordPerfect 5.0 for papers and reports, and Lotus 1–2–3 for graphs and calculations, NTSYS (Numerical Taxonomy SYStem) is employed for interpretation of isoenzyme studies.

NTSYS is a system of programs used to find and display structure in multivariate data. Current research in the Department centers on isoenzyme analysis as an aid in the taxonomic study of different fungal strains in the Collection. The NTSYS program computes various measures of similarity or dissimilarity between the electrophoretic band patterns obtained and then summarizes this information either in terms of nested sets of similar objects (cluster analysis) or in terms of spatial arrangement along one or more sets of coordinate axes (ordination analysis or various types of multidimensional scaling analysis) (ROHLF, 1988).

MICRO-IS is a second system of programs which has been employed by ATCC mycologists in a collaborative effort with other microbiologists to share information resources through computer data networks. It is an extension of the RKC Code (Rogosa, Krichevsky, Colwell) which assigns a six digit number to each feature of an organism and allows for the coding of about 10,000 features (ROGOSA & al., 1986).

The most frequently used MICRO-IS program is for the identification of unknown organisms based on conditional probabilities. This program analyzes a matrix of the frequency of occurrence of each feature within each taxon to find the "best fit." Even when computer analysis does not give a positive identification, the results reduce the number of species that have to be considered and may suggest additional tests that can be performed to improve the identification. If more than one organism is indicated, research into specific literature may be needed. The Mycology Department has been involved in the development of two coding methods using the MICRO-IS program: one for yeasts and the other for *Phytophthora* (JONG & al., 1988; JONG & al., 1990).

In collaboration with M.I. Krichevsky at the National Institutes of Health (NIH), the Mycology Department expanded the RKC system, which originally dealt with bacteria, to include fungi and yeasts. By combining certain fungal features with those of the more general coding system, a set of strain descriptors, including inventory and history, has been generated for overall storage and retrieval of yeast strain data.

The genus *Phytophthora* includes over 45 species of economically important plant pathogens, and identification of a strain to the species level can be a time consuming process. Since very few of the bacterial, yeast, or other organism characteristics overlap with those of *Phytophthora*, the Mycology Department has helped in the creation of new descriptors for the RKC Code. The set of features

include morphology, colony characteristics, growth temperatures, and descriptors of pathogenicity.

Once databases employing these two coding systems are created, they will be valuable tools for investigators in the field. Coding methods for the genus *Rhizopus* and cultures of wood decaying fungi (Basidiomycetes) and saprolegnian fungi are also being developed.

### C. Service Laboratories

The laboratory technicians use an AT&T PC 6300 for distribution records and for a yeast identification program. Keeping distribution information in a Sci-Mate database, the **Orders User File**, saves the technician-in-charge a great deal of time by eliminating the need to search through paper invoices for answers to various status queries from the Sales & Marketing or Manufacturing Departments. The following ten fields are used for distribution information; more will be added as the need arises.

INVOICE	Invoice number (IN=)
COMPANY	Customer's name (CO=)
ADDRESS	Customer's address (AD=)
ORGANISM	Species name(s) (OR=)
ATCC NO	ATCC accession number(s) (AN=)
DATE/INV	Invoice date given by Sale & Marketing Department (DI=)
REC/INV	Date of receipt of invoice by Mycology (RI=)
SHIPPED	Date of shipment (SH=)
BACKORDER	Backorder indicated by ATCC number (BO=)
B/O SHIP	Date of backorder shipment (BS=)

Use of a Yeast ID program is of great assistance to the technicians who must classify yeasts sent to the Department for identification. The program devised by J.A. BARNETT, R.W. PAYNE, and D. YARROW contains the morphological and physiological features data from their book Yeast Characteristics and Identification. After a series of tests are run with an unknown yeast, the simple "yes", "no", or "don't know" answers to a question set yield a probable identification or at least narrow the possibilities to a manageable number (BARNETT & al., 1974).

### D. Information Laboratory

The Department's Information Manager has a Compaq Deskpro 286 with a Panasonic KX-P1524 printer and uses WordPerfect 5.0. The ATCC Fungi/Yeasts Catalogue, converted to a Sci-Mate database, the **Mycology User File**, has been put on the hard disk of

the Compaq and can be quickly searched using any word, number, or abbreviation which appears in the printed ATCC catalogue.

At the present time a database for ATCC fungal cultures according to their use or application is being created. When it is completed, it will contain information that is even more detailed than that found in the publication, *ATCC Microbes and Cells at Work* (EDWARDS, 1988). This database will allow for a rapid search for answers to inquiries about products and applications of fungi in the ATCC collection essential for fungal biotechnology (JONG & BIRMINGHAM, 1989).

The PC-based laboratory management system has had a profound impact on the operation of the Mycology Department. Many standard reports are pre-formatted so that a few keystrokes can access the correct data and print it as a finished report. Information previously recorded by hand in notebooks or binders can be recorded more rapidly by keyboard and is much easier to correct. With PC's and pertinent database at their fingertips, staff can answer a customer's question immediately.

Although not yet networked, all of the personal computers in the Mycology Department are compatible; information can be easily passed among them by means of floppy diskettes. Through an HP terminal, not only the Departmental Secretary, but any staff member who requires information can easily access the Product File record of a culture.

### **Publications Department**

When a new culture is released, correspondence, reprints, lab reports, and other pertinent data is reviewed by the Mycology Department Head and sent to the Publications Department to be processed for cataloguing, indexing, and updating of the HP.

Upon receipt of this information, the Assistant Managing Editor completes a Master Card by summarizing all essential information on the culture. The card includes:

- Scientific name to be used in catalogue and other records
- Scientific name used by depositor
- ATCC number
- Dates received and accessioned
- Depositor's name, address, and strain designation(s)
- Laboratory history
- Other strain designations
- Host or substrate and geographical location of isolation
- Packaging code for safe shipment
- Shipping state (freeze-dried, frozen, or active culture)

Known delays in shipment (if any)  
Date first catalogued  
Date depositor approval received  
Source of species description for the type culture  
Special applications (e.g., uses in bioassays or for production of antibiotics, mycotoxins, enzymes, vitamins, etc.) with the pertinent reference citations  
State and federal permit requirements  
Other comments as required (e.g., mixed culture, non-sporulating culture of imperfect state, genotypes)  
Medium and growth conditions

At the same time the working manuscript of ATCC Microbes and Cells at Work is updated with any new special applications.

The Master Cards and the other index cards are manual files at present, but all of the information contained on the Master Card is entered in either the Product File on the HP or in the computerized publication system. Computerization of the strain cross-index file is underway.

Nomenclature changes and/or new uses involving ATCC fungi noted by the Mycology Department Head while reviewing the literature are sent to the Publications Department. Indexes and databases are updated accordingly. The Departmental Secretary also makes the necessary changes on the **Cultures User File**.

ATCC catalogues and related publications are edited and entered on an in-house typesetting system, only the printing and graphics are purchased on the outside. Varsity's EPICS publication system is an open-ended, clustered composition system designed to facilitate initial keyboarding, storage and retrieval of data; revision of copy; page composition; and output of composed, camera-ready documents. Software allows sorting in alphanumeric, numeric, dictionary, and user-defined order. The latter improves and automates the indexing of the catalogues. Up to eight work stations can be linked in an EPICS network. All terminals have access to the common database on hard disk, and each terminal can direct output to available typesetters, previewers, and/or proof printers. This computerized text-editing system, which allows easy updating and produces photoready copy, results in significant reductions in labor and other costs associated with catalogue production.

The seventeenth edition of the Catalogue of ATCC Fungi/Yeasts was produced in 1987. It contains over 21,000 strains listed by species name and indexed by ATCC accession number and industrial applications. Data include: source, nomenclature, taxonomy, biotechnology, genetic engineering, genetic information, bioprocesses and products, assays, pathogenicity, toxicology, biological controls, sen-



sitivities, materials testing, availability, literature citations, culture conditions, and permit requirements (JONG & GANTT, 1987). Two annual updates to the seventeenth edition have been published. Because of the size of the present catalogue, future editions will place the fungi and the yeasts in separate volumes.

Currently ATCC's system with 150 megabytes of online hard disk storage is composed of three work stations, the CPU, a digital typesetter with an output speed of 200 newspaper lines per minute, and telecommunications software which allows EPICS to communicate with other ASCII-based computers through modems and a PC hard-wired to EPICS. Through the telecommunication link on EPICS and on an IBM-compatible PC, the EPICS catalogue files can be converted to ASCII files on diskettes. In 1989, the fungi/yeast catalogue was transferred from EPICS to the Mycology Department PC's and updated EPICS files will also be transferred to the Department.

As the number of fungus strains within a species increases, it is very difficult to locate a particular one without extensive cross-indexing. Using the HP, a strain index is being produced for use in printed catalogues. The advent of online versions of the catalogues and eventually other electronic forms such as CD-ROM will allow free-text searching of strain designations. Currently the Publications Department produces electronic versions of two printed catalogues (Protists and Bacteria) which are available worldwide through the MSDN/CODATA Network.

A database known as the Product File is maintained by the Publications Department on the HP and is accessible throughout ATCC via the program Product Inquiry. It contains records accessible by ATCC number for all ATCC materials. The records contain pertinent data received from the laboratory when new strains are accessioned. Only the Publications Department can change information in the Product File, and the date of the last change is noted. The Product File record is composed of:

ATCC number

Organism name

Depositor codes which specify the collection, kind of organism, and departmental ledger account

Text for printing vial labels when required

ATCC growth medium number

Special growth conditions (e.g., anaerobic, black light, etc.)

Growth temperature

Acquisition date

Availability status (in progress, available, on hold, deaccessioned)

Whether it was received as a patent deposit

- Whether it is catalogued
- Whether it is taxable
- Whether it is an ATCC Preceptrol™ culture
- Whether an export license or government permits are needed to ship the culture
- Packing class for etiologic agents which determines how the culture will be packed and shipped
- Form in which it is shipped (test tube, freeze-dried or frozen)
- Whether there is a shipping delay
- Any special comments

Codes allow retrieval on whether a culture has been determined to be useful for education, industry, environment, agriculture, fermentation, testing, or health.

When a culture deposited for patent purposes is restricted at the request of the depositor, only the accession number, name, and a notation that it is not available will appear in the Product File. The record is updated when the culture is released.

### **Sales & Marketing Department**

The Hewlett-Packard 3000 Series 950 has 3.3 gigabytes of disk storage, 80 megabytes of internal memory, one tape drive, and 70 terminal/printer ports. Presently 52 ports are in use, seven for printers and 45 for terminals. Operated by the Computer Systems Manager, the computer serves the Sales & Marketing, Accounting, and Manufacturing Departments. It is programmed with custom software for order processing, shipping documents, inventory control, invoice generation, accounting records, sales history files, and management reports. All orders are entered into the computer, and inventory reductions are automatically made. The system allows immediate response to customer inquiries, order-status, shipping requirements, and availability of cultures. It also produces management reports for sales analysis by culture or by customer, open order status, general inventory, critical items (low in stock), culture history reports, and distribution by number of cultures per category and dollar values.

The Sales Department processes all orders for ATCC materials through the HP, using the Product File and inventory records described elsewhere. The Technical Service Representatives also utilize manual and electronic files provided by the Publications Department to answer questions.

### **Manufacturing Department**

Hewlett-Packard terminals located in the Manufacturing Department are employed to maintain inventory of all cultures in the

Collection. The complete inventory is accessible in the Quick Inventory File by all ATCC staff, but change in inventory figures is restricted to the Manufacturing Department. Only the number of cultures available for distribution appear in the Product Inquiry record.

Fungal cultures are preserved and stored by two methods. If a culture can be successfully freeze-dried, the distribution stock is preserved by this method but the seed stock is frozen. For cultures which cannot tolerate freeze-drying, both the distribution stock and the seed stock are frozen. After newly preserved cultures are processed by the Mycology laboratory, Manufacturing enters the number of vials and the storage locations into the inventory record. Data on the freeze-dried and frozen cultures are usually handled separately by personnel at different terminals.

Actual inventory numbers are entered by Manufacturing under various restriction codes:

- (WH) withheld because the batch has not as yet been released by the laboratory for distribution,
- (DI) distribution stock,
- (SE) seed stock,
- (SF) off-site frozen safety deposit stock,
- (SV) off-site freeze-dried safety deposit stock, or
- (LN) liquid nitrogen stock.

The liquid nitrogen stock is used by the Mycology laboratory for orders shipped in test tubes. When the laboratory approves the release of a culture from the withheld status for distribution, Manufacturing will change the location code to the nonrestricted "DI". When a batch is released, the new total available for distribution appears in the Product Inquiry record.

Manufacturing does not deduct the cultures which are sold; the order processing programs do that automatically. It does, however, manually deduct any culture requested by the Mycology laboratory for its own use from either the withheld, distribution, or seed stock. It also deducts any culture requested by the laboratory from liquid nitrogen stock and any culture sent by the Department to a depositor as an exchange. Occasionally, a culture must be retrieved from the off-site safety deposit location, and Manufacturing makes the adjustment in the inventory.

The information on how a culture is to be shipped is sent by the Mycology Department to Manufacturing at the same time it is sent to Publications for entry into the Product File. The distribution inventory record is created by Manufacturing for fungal strains distrib-

uted in test tubes. This results in a non-depleting inventory of one and allows the HP to process orders.

### **Bioinformatics Department**

The Bioinformatics Department of the ATCC utilizes the other two on-site minicomputers. The MicroVax II with 11 megabyte RAM has two 70 megabyte and two 150 megabyte hard disks. Software includes a C compiler, a Fortran compiler, Datatrieve for interactive queries and report writing, and Rdb, a relational database management system. The MicroVax is used to maintain a database of the recombinant materials processed by the Molecular and Plasmid Biology Department which include clones, libraries, hosts, and vectors. Information on human and mouse gene probes and libraries is accessible to the public online.

The Sun 4/110 (8 megabyte RAM and a 327 hard disk) stores the data for a Department of Energy (DOE) pilot repository, which includes clones of the *Saccharomyces cerevisiae* genome. Software for this system consists of the UNIX operating system and SYBASE, a relational database management system.

Via the MSDN/CODATA Network (Microbial Strain Data Network/Committee on Data for Science and Technology) ATCC offers online ordering of its products and online access to its databases. Questions directed to ATCC departments via electronic mail are distributed to appropriate staff members for answers.

Mycology Department data are listed on the MSDN/CODATA Network. The MSDN is a Task Group of CODATA established to act as a locator service for microbial strains and cell lines with particular attributes by an indirect method. The repositories of microbial strain data become Network Informational Nodes. When a Node is located which codes information on the desired data features, the person querying MSDN contacts the Node directly. MSDN supplements but does not duplicate the specific strain databases.

### **Library**

#### *A. Mycology Reprint Collection*

The ATCC Mycology Department reprint collection is indexed by author, complete publication citation, and subject. Subject entries are chosen by the Head of the Mycology Department. Each reprint is given a unique number. A Sci-Mate database was developed for quick retrieval. New reprints are checked against existing holdings to prevent duplication.

### *B. Online Searches*

Innumerable online databases from vendors such as DIALOG and MEDLARS are available for searching to satisfy subject inquiries or to verify bibliographic citations. In 1989, the following 26 databases were searched:

Agriculture and Nutrition: AGRICOLA, and CAB ABSTRACTS  
Bibliography for Books and Monographs: BOOKS IN PRINT, BRITISH BOOKS IN PRINT, LC MARC-BOOKS, and REMARC

#### Business Information

Public Companies: DISCLOSURE DATABASE, INVESTEX, and MOODY'S CORPORATE PROFILES

Corporate Directories: D&B-DUN'S FINANCIAL RECORDS PLUS, D&B-DUN'S MARKET IDENTIFIERS, and STANDARD & POOR'S REGISTER-CORPORATE

International Companies: ICC INTERNATIONAL BUSINESS RESEARCH

Financial News: STANDARD AND POOR'S NEWS

Chemistry: CA RESEARCH

Law and Government: GPO MONTHLY CATALOGUE

Medicine and Biosciences: BIOSIS PREVIEWS, CATLINE, EMBASE, MEDLINE and MERCK INDEX ONLINE

Patents and Trademarks: CLAIMS/ US PATENT ABSTRACTS

Reference: AMERICAN MEN AND WOMEN OF SCIENCE, BIOGRAPHY MASTER INDEX, and ULRICH'S INTERNATIONAL PERIODICALS DIRECTORY

Science and Technology: COMPENDEX PLUS and STANDARDS AND SPECIFICATIONS

The two databases which are most widely used by the Mycology Department are BIOSIS PREVIEWS, with worldwide coverage of research in the life sciences, and AGRICOLA, with worldwide coverage of agriculture and related subjects.

The ATCC library can also access OAG (Official Airlines Guides) Electronic Edition for unbiased worldwide coverage of airline flight schedules, fares, hotel and motel locations, rates, and quality ratings for use by the ATCC staff.

### **Discussion**

Many culture collections are still using traditional paper-based data management methods for their data. These methods for accessing data resources are satisfactory as long as the answers are not voluminous and are not needed quickly. As the queries become more

involved, e.g., the availability of a single strain exemplifying a particular taxon or having certain attributes, these methods become less satisfactory to both the seekers and providers of information. The provider must devote increasing resources to answering queries, taking professional expertise that could be used in the other work of the collection. Therefore, any mechanism which minimizes the labor involved in data search increases the professional resources of the culture collection. The best source for specific strains will often be the collection with the most available data rather than the one with the most complete selection of strains with likely sets of characteristics.

Both internal and external mechanisms can be used by culture collections to ease the workload of a data search. Internal mechanisms include publications, such as catalogues, and computer management of the data for ease of searching and reporting. The Mycology Department of the ATCC has not only produced a comprehensive printed catalogue for many years but has introduced a PC-based laboratory information management system. Operations are smoother and more efficient, and far more valuable use is now being made of the accumulated strain data. The plan is to make this data available throughout the ATCC by networking the pc's through the Office of Management Information Systems.

External mechanisms are primarily electronic forms of communication. Public access to data in collections can be accomplished in two ways. Data are made available by access to a computer system maintained by the collection, e.g., the Human Gene Probe Bank at the ATCC. The second approach is to install the data in a database operated outside of the collection. For example, ATCC has installed data, under control of the Collection, on the MSDN/CODATA Network.

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# ZOBODAT - [www.zobodat.at](http://www.zobodat.at)

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [Sydowia](#)

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