A picture is worth a thousand words but how do you find it?

Charles T. Bargeron IV, Computer Services Specialist IV, Department of Entomology, College of Agricultural and Environmental Sciences, The University of Georgia, Tifton GA
G. Keith Douce, Professor of Entomology, Department of Entomology, College of Agricultural and Environmental Sciences, The University of Georgia, Tifton GA
David J. Moorhead, Professor of Forestry, Warnell School of Forest Resources, The University of Georgia, Tifton, GA

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Abstract

Biological images are extremely useful in the educational process. However, slides or photographs are difficult to catalog or identify. Using Kodak PhotoCDs, relational databases and Web technologies, a system for entry and retrieval has been developed as a joint project between the UGA Entomology Department and the Warnell School of Forest Resources, and Georgia Southern University Computer Science Department.

Introduction

Forest resource management decisions must be based upon correct identification of insects and diseases with an understanding of the complex biology of the ecosystem in which they operate. Since forest insects and disease organisms are small and varied, the availability of good images aids greatly in identification. However, ready access to quality pictures of these organisms and their damage has been a problem for many people.

Talented photographers throughout the years have taken many high quality photographs of forest health organisms. These images typically exist as 35mm slides in laboratories, field offices, and individual professionals' slide files. Unfortunately, as individuals retire or are promoted, or as offices and personnel change, these images are misplaced or are no longer available. Additionally, unless individuals duplicate these slides and distribute these duplicates to others, then only the holder of the original slide has access to that image. Many times as duplicates are made and slides are passed along to others, vital information about the slide is lost such as photographer, subject identification and description of the image. This immediately limits the usefulness of the image.

Emerging Information Technologies (IT) including the Internet and World Wide Web (WWW), portable computers and presentation software and equipment (such as Microsoft Powerpoint and computer projectors) and desktop/publishing software systems provide exciting opportunities to deliver timely and quality information to diverse audiences. These IT technologies allow multimedia presentations to be made that incorporate sound, text, images and video. Additionally, most printed materials are now developed and delivered to printers via computer software, which again requires images to be in digital form. Before presentations and programs can be delivered using these technologies, they must be converted to a digital format. Of particular importance to transferring educational and identification information to users, is the availability of quality digital images. Several limitations are immediately evident to anyone desiring to use these IT:

1. location of desired, high quality pictures,
2. access to the images when needed,
3. digitization of these images in forms and formats that are suitable for the desired application,
4. availability of the biological and descriptive information needed, and
5. ability to use the images in several applications.

In short, the availability of digitized, documented forest health images is very important to the education...
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**Background**

In 1995, Drs. Keith Douce and David Moorhead formed the Entomology and Forest Resources Digital Information Work Group. Dr. Keith Douce is an Extension Entomologist in The University of Georgia, College of Agricultural and Environmental Sciences. His responsibilities include forest entomology, integrated pest management and coordinator for the USDA-APHIS-PPQ sponsored Cooperative Agricultural Pest Survey program. Dr. David Moorhead is an Extension Forester in The University of Georgia, Warnell School of Forest Resources. His responsibilities include forest regeneration, silviculture, forest management, prescribed fire, forest herbicides, forest IPM, and Christmas tree production. As Extension specialists, they provide educational information and training for Extension agents, landowners, foresters, and resource managers. The Work Group consists of Drs. Douce and Moorhead, computer specialists, and secretarial support. Work Group activities include development of projects using multimedia, web sites, and computer imagery to enhance their work in entomology and forestry education. In order to assist these projects, a high quality image archive containing images of primary US forest insects, diseases and management practices has been developed. The archive consists of over 4000 images digitized in Kodak Photo CD format that originated from 35mm slides selected from slide libraries across the US, primarily from US Forest Service photographers, research stations and forest health protection units as well as State Forest Service office, USDA APHIS-PPQ and University personnel. However, locating various images and information relating to the images quickly became a problem. A database management system was designed and implemented to allow for efficient retrieval of images and their related information including, for example, subject, biological, taxonomic, and photographer information. The correctness of this information is imperative to properly identify each image. Using a properly implemented relational model, data integrity can virtually be insured.

The Work Group personnel developed several prototypes of this image archive database internally over a period of about four years. However, the authors recognized limitations and problems with each of them. In 1999, Mr. Bargeron was enrolled in an advanced database management systems/software engineering course at Georgia Southern University taught by Dr. Anne Pierce. Part of the course requirements included a team of students to develop an operational database application. The team consisting of Mr. Charles Bargeron, Lee Phillips, Greger Jacobsen and Jason Smith decided to undertake conversion of the existing image archive data system into a fully operational, relational database application. The students worked closely with Drs. Douce and Moorhead and gathered information from the previous work on the project to develop a flexible, but precise, relational database management system. From the system's initial stages, migration to other disciplines and availability of the entire archive to world via the Internet has been considered.

**The Current System**

The Bugwood Collaborative Image Database system that was developed by the computer science students at Georgia Southern University serves as a foundation for the project. The initial system was developed using Microsoft Access 97 relational database management system software. This system was developed to provide desktop access to the database by members of the Work Group which currently consists of seven full and part-time University of Georgia employees. Information can be retrieved, added, updated and deleted from each of the seven computers currently running the system.

Information about nearly 5000 images currently in the Work Group archive is now stored in the database. Information related to the image includes:

- Photographer information
- Contact information (if the image was received from someone other than the photographer)
- Subject information, including full scientific classification, breakout categories and world region
- Domain and Area of each image (Scientific discipline and hosts of pests)
- Full descriptions
- Projects (printed and electronic publications, slide sets, etc.)

This information is stored in an individual database tables following the properly normalized relational model. This helps to protect data and referential integrity by virtually eliminating duplication of information. For example, each subject's scientific information is only entered once and then referenced to the images to which it refers.
The database application provides a user-friendly environment for desktop use of the database over a local area network. The backbone of the system that was originally developed using Microsoft Access 97 was migrated to Microsoft SQL Server 7.0 to enhance performance and take advantage of higher throughput capacity this software offers. This required only slight modifications to the original application. The key features of the desktop application include the following:

- Data entry
- Data retrieval
- Report and legal release letter generation
- Statistics on numbers of images by author, subject, category, domain and project
- Administrative access to protected tables and database design

Training required for the operators of the database application has been minimal. Only slight modifications to the original system have been made as historic and new image information has been entered.

Related Projects

The driving force until recently for the development of the image archive and related database has been the other Entomology and Forest Resources Digital Information Work Group projects. The projects fall into two major categories, for sale CD-ROMs and web site development.

The Work Group has three major CD-ROM products currently available or in the final stages of production.

Forest Insects and Their Damage

Forest Insects and Their Damage is a two volume Photo CD set with two hundred high resolution images from the Southern Forest Insect Work Conference slide series. The CD set includes a booklet with full references and descriptions of the images.

Forest Pests of North America

Forest Pests of North America is a three volume Photo CD set with three hundred high resolution images gathered from slide collections across the United States. These CDs contain one hundred and fifty forest disease and one hundred and fifty forest insect images. This CD set includes a booklet with full references and descriptions of the images.

Forest Pest Control Multimedia Supplement

The Forest Pest Control Multimedia Supplement provides an enhanced, interactive electronic version of the manual used for training for the Environmental Protection Agency pesticide certification in the Forest Pest Control category. The electronic version adds additional images and practice tests.

The second category of projects is the Bugwood website. The Bugwood website began as an electronic delivery system for printed Work Group publications. It has now grown into a network of sites and is in its fifth generation. The network of sites has received over 2 million hits and averages ten thousand unique visitors each month. The site has achieved recognition for both content and design and is recognized internationally for achievements in electronic communication. The Work Group has taken a proactive outlook and is digitizing many USDA Forest Service and University of Georgia publications for availability on the Bugwood Network. The Bugwood Network also hosts and develops sites for related groups. The Bugwood Network currently consists of the following sites:

Bugwood Library

The Bugwood Library gathers, creates, maintains, promotes the use of, and economically distributes digital information both as resources and as tools to enhance and complement information exchange and educational activities primarily in the fields of entomology, forestry, agriculture, forest health and natural resources.

Georgia Cooperative Agricultural Pest Survey

The Cooperative Agricultural Pest Survey (CAPS) is a combined effort by Federal and State agricultural
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organizations to conduct surveillance, detection, and monitoring of exotic and/or non-endemic crop pests and biological control agents. Survey targets include weeds, plant diseases, insects, nematodes, and other invertebrate organisms. The Georgia CAPS website provides support and information about survey pests, projects and activities of the Georgia program.

**Georgia Integrated Pest Management**

Integrated Pest Management is a knowledge-based approach to crop protection that requires readily available information for its successful implementation. Integrated Pest Management is very important to many areas of agriculture in Georgia. The Georgia IPM website provides commodity-based information to support work in this area.

**Africa – Forestry, Agroforestry and Environment**

**Africa – Eastern Arc Mountains Project**

**Africa – Tree Pest Management Network**

The three websites devoted to Africa were designed to support and enhance projects being carried out in Eastern and Central Africa by Drs. Douce and Moorhead and their cooperators and collaborators to promote the protection, health and sustainability of African Forests, Agroforests and Forest Environments. These websites primarily focus on work in east Africa and are built with partnerships between the University of Georgia, USDA Forest Service, USAID, Kenya Forest Health Centre, Moi University, Sokoine University and others.

**Southern Forest Insect Work Conference**

**Georgia Entomological Society**

The Bugwood Network hosts and maintains websites for these organizations. These sites provide information about the activities of each of these organizations and provide mechanisms to improve communications and information transfer related to these organizations.

The image archive has served as a source of images for all the Work Group activities including images for the CD-ROMs, Bugwood Network interface, and publications available on the Bugwood sites. The website and high-resolution images will be merged together to provide a powerful informational and educational tool.

**The Future System**

Plans are underway and development is in progress for migration of the forest health/forest IPM image archive to the Internet. This archive will be available for browsing, selection, and downloading of "screen-level" resolution images in JPEG format. Plans are underway to develop a "shopping cart-type" of feature to allow users to browse the images selected by their image query, select images which they would like higher resolution versions of the image and provide an easy interface for acquiring appropriate image files. These images will be available for downloading or can be written to CD for a small handling charge. This system will become the premiere source for forest related images in the world, and will be supplemented by the Bugwood web library of publications and fact sheets. This will be a unique system combining high quality images and textual information in one location.

This forest health/forest IPM system will act as a model for future systems and work is already in progress to build similar archives for areas of plant protection, integrated pest management, silvicultural practices and other related disciplines. Digital images, relational databases, and the World Wide Web combine to provide a resource previously unavailable to educators, professionals and other interested parties.

For more information about this and related projects, visit our web site at http://www.bugwood.caes.uga.edu/

**References**

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