Soil Life by Digitized Video for the Internet

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ABSTRACT

Much of the living component of soil is too small to be seen with the unaided eye. Although still images can be used to introduce students to soil life, they are not nearly as interesting and effective as video. Good quality video, however, is not readily available. This article introduces a WWW (world-wide web) resource containing 16 short, digitized-video clips of different soil organisms. The site should be a valuable resource for high school biology teachers, college teachers of introductory soils, geology, and natural resource courses, and those developing distance-education programs. By publishing the URL (uniform resource locator), potential users know the site contents have been peer reviewed. The article briefly introduces potential users to the language and limitations of digitized video. The Web site containing the video clips of soil life is at:

http://www.agron.iastate.edu/~loynachan/mov/

[URL, 1 Apr. 1998].

FASCINATING ORGANISMS that live in the soil have developed ways of surviving in a strange and darkened world. Some of these organisms (earthworms, beetles, millipedes, slugs) are large and readily seen with the unaided eye. But most of soil life can only be viewed with the aid of a microscope. Undoubtedly, the best way to view organisms is using live specimens, but because of the media requirements and preparation time, this often is impractical (Heckman and Strick, 1996). Other options include use of slides, video cassette tapes, CD-ROM (compact disk read-only memory), and images from the Internet.

Making teaching materials available on the Internet holds great promise because of easy access to anyone around the world (Logan, 1996). No longer will users need to directly obtain the materials from the provider. Also, the information provider can readily update information on the server, whereas with slides, video cassette tapes, or CD-ROM, the media must be replaced at the location of use. Recent estimates indicate that nearly 30% of K–12 public school classrooms now have access to the Internet—more than twice that reported just 12 mo ago (Anonymous, 1998). All evidence suggests this trend will continue in the future.

Video is a great way to bring students new excitement, stimulating greater interests in subject matter. This is especially true when viewing living organisms that move, eat, breathe, and die. Video can be effectively used in disciplines where visualization aids understanding. Because it is difficult to understand things not seen, video promises to be an important teaching tool in soil biology. As video and computer technologies mature and grow, educators will rely more on video to convey course content, both in the classroom and on the Internet. Computer technology also opens many new opportunities for distance education. An estimated 55% of U.S. 4-yr colleges and universities now have courses available off-site (Schurle, 1997).

Soil life is often introduced in high school biology courses or introductory college soils courses. Without video, visualization is restricted to still images from slides or photos; with video (video cassette tape, CD-ROM disk, or now files from the Internet), visualization can be enhanced by showing the movement of living organisms.

PRESENTATION DELIVERY METHODS

To select the most appropriate methods for presenting visual images in the classroom, the instructor needs to compare the available methods for presentation.

Slides

Slides are the traditional means of conveying images in a classroom. They are relatively cheap to produce, equipment for projection is readily available, and the presenter can control the order and length of the presentation. Two major limitations exist: (i) physical access to the slides is needed for showing, and (ii) slides lack motion.

Video Cassette Tapes

Video cassette tapes offer the advantage of incorporating motion and sound. They are expensive to produce but less expensive to copy. Equipment for playing is readily available in most classrooms, although images are small without proper projection equipment. The order and length of the presentation is primarily controlled by the medium and not by the presenter. The presenter can start, stop, and skip portions of the tape. The presenter physically needs a copy of the tape for presentation. In a survey of crop science instructors (Elkins, 1994), 71% who used video cassette tapes felt they were important, very important, or essential in meeting course objectives.

CD-ROM

CD-ROM files are compatible with newer computer technology and provide motion and sound. They are expensive to produce and expensive to copy, but the presenter can control the viewing order. The digitized images can easily be converted to TIFF or PICT files for use as stills in other presentation formats. For good quality images to be viewed from a digital projector in a classroom, file sizes must be large (see later discussion). The presenter needs physical access to the CD-ROM to play. The rate of download and play is controlled by the CD-ROM drive speed. CD-ROM drives process data relatively slowly compared with a CPU: single speed is about 90 to 100 kbps (kilobytes per second);

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Abbreviations: CD-ROM, compact disk read-only memory; codec, compression/decompression software; CPU, central processing unit; PC, personal computer (often used to describe IBM compatible machines); kb, kilobytes; kbps, kilobytes per second (unit of data rate measurement); Mb, megabytes; URL, uniform resource locator (site address); Web, common term for the World Wide Web.

double speed, 200 kbps. Most newer machines have drives 16× or faster. CD-ROM disks hold 650 Mb (megabytes) of data, but this space can quickly be filled for large-screen presentations involving motion. For example, a CD-ROM disk can hold about 10 min of video at an image size of 480 by 360 pixels (suitable for projection on a 2.5-m screen).

Internet

The Internet offers the advantages of CD-ROM plus presenters do not need physical assess to the material since it is delivered when needed. Thus, delivery can be made to anyone around the world who has access to the Internet, providing widespread dissemination. Because of large file sizes, download times can be long, especially when connections are by slow modem. Technology is changing rapidly, and state-of-art movies and delivery systems today may be obsolete tomorrow. It seems clear, however, that use of Internet delivery, in some form, is the way of the future. King (1997) reported business and industrial training programs delivered by Internet grew by 87% in 1996, those delivered on CD-ROM grew by 53%, while the number of instructor-led training programs fell by 13%. Two limitations now exist, but they may be short lived as new technology develops. Currently, users have free access to most materials on the Internet. Unlike slides, video cassette tapes, or CD-ROM disks that are sold to the user, the financial incentive for the developer to produce new teaching materials is minimal. Perhaps users in the future will be charged a fee for use of teaching materials available on the Internet. The second current limitation is Internet bandwidth, which is discussed below.

DIGITIZED VIDEO

Playback on a computer, either by CD-ROM or from the Internet, requires that video and audio clips be digitized. Digitization is still in its infancy, especially for Internet delivery. Large-scale distance learning initiatives may be among the first to offer Web video routinely in course offerings. In a distance-education course taught earlier by satellite, Salvador et al. (1993) reported that students gave high ratings to the use and educational value of the multimedia teaching method.

Digitized full-motion video requires huge amounts of computer memory. A 13-inch monitor requires a 640 by 480 pixel image to fill the screen (a pixel equals one dot in a video or still-image frame). At 72 pixels/inch, this equals 307 200 pixels/screen. For 8-bit RGB color (256 color), each pixel requires 24 bits of information (24 bits equals 3 bytes). Thus, a full-screen image requires just short of 1 Mb of data.

Compression/decompression (codec) is required to reduce and manage huge files of data and to allow for adequate rates of playback. Compression restructures data to decrease file size. Side-by-side frames are compared and, if the data at each pixel remains unchanged, information can be stored as one piece of datum. Thus, compression removes redundant data. For more dramatic size reduction, less important data may also be removed, resulting in loss of sound or image quality. Decompression takes place as the movie is played, and rapid decompression allows the movie to appear in real-time. A frame that takes several seconds to compress may decompress in 0.067 s (1/15th s) or 0.033 s (1/30th s). Playback rate determines how smooth and natural-looking the movie appears.

Table 1. Parameters used to generate Web site digitized video of soil life.

Video data rate	40 kbps
Size	256 × 192 pixels
Codec	Photo-JPEG
Quality	50
With controller	yes
Title image duration	1 s
Action segment duration	2–4 s
Movie duration	10–15 s
Movie file size	363–759 kb

Many movies are written to one of several codecs supported by QuickTime, although other codecs are available and may become the standard in the future. QuickTime is free software and can be viewed both by PC and Macintosh computers. A QuickTime plug-in (readily added software) comes with Netscape Navigator 3.0 and newer versions, so downloading additional software is not required to view QuickTime movies.

Digitized video involves trade-offs between image and sound quality and file size. A large image format and good sound, playing 30 frames/s (for smooth motion), will generate monstrous files. Smaller images with poorer sound, playing fewer frames/s (with a more jerky motion), will generate smaller files. Additionally, the more the file is compressed the smaller the file size, but the poorer the movie quality. One major limitation in delivering movies by the Internet is bandwidth, which is the amount of information that can be sent and processed in a given time. For example, a 28.8 baud modem has a bandwidth of approximately 2.5 kbps. A 500 kb movie would take 200 s (over 3 min) to download. Compare this with a CD-ROM drive (double-speed) that has a bandwidth of approximately 200 kbps. Fast 56.6 baud modems are available but the most prevalent connection rates on the Internet presumably will be 14.4 and 28.8 baud for some time. A fast network connection (T1) has a theoretical limit of 150 kbps, but the realities of the Internet system usually slow these connections to a few tens of kbps.

WEB SITE DEVELOPMENT

Soil life video was generated during a senior-level soil biology class at Iowa State University in the fall of 1993. The video was digitized without compression by using Adobe Premiere. Clips were edited, a title slide prepared, and transitions formed in Premiere. Files were exported from Premiere to Media Cleaner Pro 2.0 for compression.

Media Cleaner Pro 2.0 allows two compression options for Internet movies supported by QuickTime software: Photo-JPEG and Cinepak. Sample movies were compressed by both softwares and file size and image quality evaluated. For these materials when projected on a classroom screen, JPEG gave the better quality images with comparable file sizes.

For Internet delivery, no audio was used in the short 10- to 15-s clips. Audio would clearly add interest but, if present, would presumably be music; it is hard to say anything meaningful in 10 to 15 s. The Web pages developed have

one-to-several introductory sentences that can be read before, during, or after playing the movie clip. Even with these short clips, file sizes were approximately 500 kb (Table 1).

To add interest in the opening page of the Web site, clickable icons of high-quality still frames were used (Fig. 1). These images take longer to download than just using linked text, but the viewer is more likely to continue to other pages with an interesting opening page. At the end of each movie, the last freeze-frame was chosen to leave a good parting impression. With Premiere, the exact single parting frame (15 or 30 frames/s) can be chosen. When playing, the controller at the bottom of the screen is standard for QuickTime movies. One can play, pause, rewind, advance, and use the slider to move to any location in the movie.

The 16 digitized video clips developed, in alphabetical order, were actinomycetes, algae, bacteria, earthworms, ectomycorrhizae, endomycorrhizae, fungi, mites, mixed fauna, nematodes, nematode-trapping fungi, protozoa, rotifers, springtails, view microscope (allows one to relate to viewing images under a microscope by showing a mite at 40, 100, 500, and 1000× magnification), and vorticella. The larger the organism, the more the action. Smaller organisms often must be stained (and dead) for viewing under a microscope, but panning views can give a sense of motion.

Class presentations by digital projectors require large format for clarity. Small formats can be viewed full screen, but the magnified pixels making up the image become unacceptably blurred. With projection equipment in our classrooms, the minimum image size for acceptable projection on a 2.5-m screen was 480 by 360 pixels. The 256 by 192 format used in the Web video was too grainy. Longer video clips have been developed in the larger format and are available on CD-ROM disks. A 650-Mb disk holds about 10 min of video with Cinepak compression. If you have an interest in reviewing a CD-ROM version, please contact the author.

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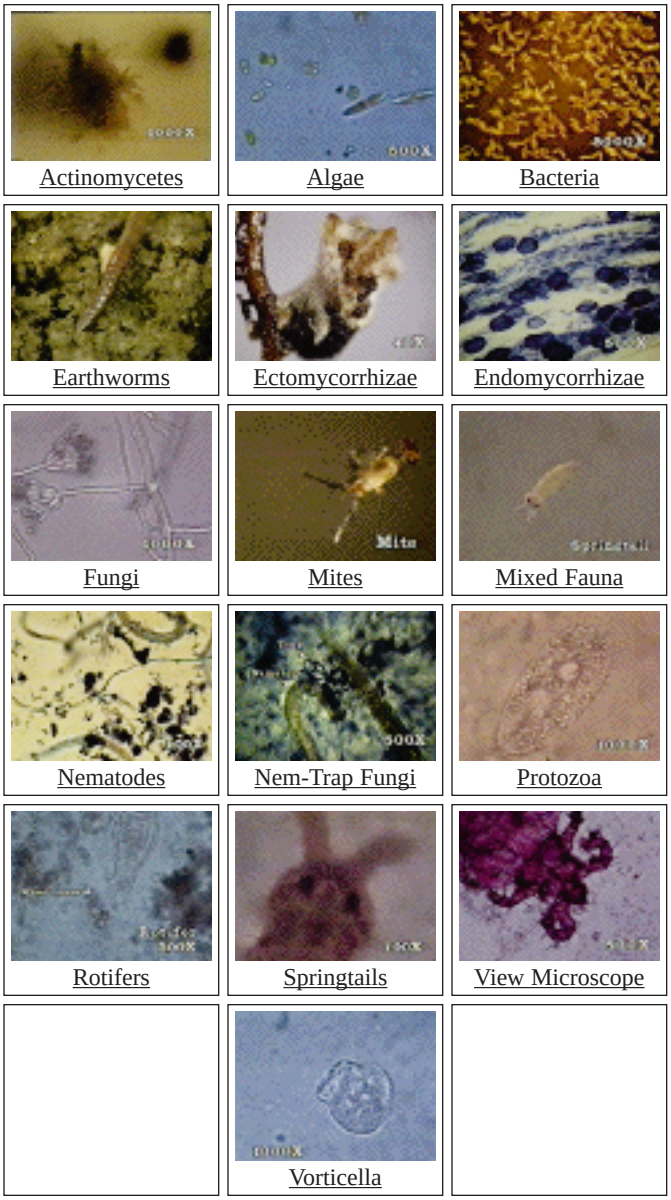
Soil Biology Movies

This page contains clickable icons of 16 QuickTime™ movies on life in the soil. If working from a slow modem, this page may take up to a minute to download. The movies are about 500 kb each and play for 10–15 seconds.



These movies were produced by T. Loynachan and are on a server at Iowa State University.

To see longer versions of selected movies from this page and movies available elsewhere, click here.

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Fig. 1. The Web site homepage of soil life video. Each of the 16 topics is identified by a caption and a high-quality still image. Both are clickable to open the Web page containing the movie and opening description.