TAXON 39(4): 576-585. NOVEMBER 1990

VIDEO FLORAS: A NEW TOOL FOR SYSTEMATIC BOTANY

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Summary

Interactive videodisc information systems are explored as a format for the publication of floras. Images (drawings, photographs, etc.) are very useful in the important task of plant identification. The enormous image storage space and the random access capacity of videodiscs coupled with the information management capacity of personal computers can be an effective and cost-efficient tool for addressing the botanical information needs of botanists as well as interested non-botanists. Especially such systems would be helpful in the informational tasks involved in preserving the threatened biodiversity of the world's plants.

The Rationale for Floras

There are many types of floras (Frodin, 1984). All share the principal objective of summarizing a sector of the available information on the plants of a certain region. This compilation of knowledge may be only the listing of known species, e.g., *Listados Florísticos de México* (Instituto de Biología, 1983–) and perhaps their common names, e.g., *Flora Yucatanense* (Sosa et al., 1985). They can include detailed botanical descriptions, e.g., *Flora Malesiana* (Steenis, 1950–) and *Flora of Veracruz* (Gómez-Pompa et al., 1978–), or only diagnostic descriptions, e.g., *Flora Europaea* (Tutin et al., 1964–1980) and *Flora of the Valley of Mexico* (Rzedowski and Rzedowski, 1979–). They may include comprehensive literature reviews and a summary of the most important available knowledge on each species such as the *Biological Flora of the British Isles* (British Ecological Society, 1941–) and the *Generic Flora of the Southeastern United States* (Wood, 1958–). They can be fully illustrated, e.g., *The Native Trees of New Zealand* (Salmon, 1980) or only partially so or not at all, e.g., *Trees and Shrubs of Mexico* (Standley, 1920–1926).

The principal objective of any flora is to help in the botanical identification of the plants of a region by the non-specialist. This can be accomplished by botanical keys, local names, illustrations, and their descriptions. This objective is met with some constraints by many floras but not by all. Major problems are the lack of keys, the incompleteness of keys, the complexity of botanical descriptions for non-specialists, lack of help within the text and lack of illustrations.

Since botanical identification seems to be the main reason for floras, let us review the more common steps in botanical identification.

Suppose our user is a non-botanist from a little town in Veracruz. This person wants to identify some unknown plants of local economic potential and wants to find what is known about them. The best first choice is to send his or her collections to a local herbarium and ask the local taxonomist to identify the plants. If that action is possible, the problem is solved and no flora is needed.

But there may be no local taxonomist in the area. Or the one who is there may not have the time to deal with this request. In such a case, the user will need to use an available flora to identify the plants. Several approaches can be followed. One is to look under the common name and find its corresponding scientific name. For this purpose, a checklist with local names is very useful. However, even if this venture is successful, the question still remains: is the plant in hand in fact the same species as that located in the checklist?

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Common names often do not coincide with scientific names. The only way to resolve this doubt is by reading the botanical descriptions in a descriptive flora (such as the *Flora of Veracruz*) and by comparing the collection with the illustrations available. Unfortunately the illustrations are incomplete, since only one species per genus is depicted in this particular flora.

The other normal procedure is the use of keys. Floras usually have keys for the identification of species within a family. There are also a few keys for the identification of families of flowering plants on a world wide basis (Hutchinson, 1967; Cronquist, 1988). Furthermore, in the case of Veracruz, there is an additional procedure: the use of a computer-aided program for the identification of the families of flowering plants of Veracruz (Allkin, 1981).

Let's suppose our user has found a possible identification for her/his plants through use of the *Flora of Veracruz* keys. The plants that have been tentatively identified as belonging to a species illustrated in *Flora of Veracruz* may well look like the drawings for that particular species. But what about the plants that may belong to species (not to mention the subspecies, varieties and forms) that have not been depicted or even included in this particular version of the flora. How can we be really sure if the name found is in fact that of the plant that our user has. The only certain way to remove all doubt is comparison of the specimens with others that have been correctly identified. Unfortunately this procedure is almost impossible to follow because the best collections for comparison are not easily accessible. They are located in major herbaria in Mexico (Xalapa, Mexico City) or abroad (Chicago, Cambridge, Washington). The user can send the specimens to these herbaria for identification by the resident experts. But their backlog is enormous. Even if the specimens are accepted, the elapse time before response may be several years.

Hence, the lay person, and very frequently the local taxonomist, will have only the local floras as their main source of information. Unfortunately, the local floras for most tropical regions do not exist or are not finished. For example, *Flora of Veracruz* has published in the last 14 years only 60 of the 300 families known to occur there.

The result of these frustrations is the frequent use of incorrect names and disenchantment with both the procedure and the results. Another consequence is often the discouragement of local amateurs (whose reward sometimes is only to name a rare plant) from the exploration of the plant world.

It seems that everything has been planned to restrict the process of plant identification to the very few centers in the world that have large and historically deep collections and library resources. The backlash of this restriction has been increasing misunderstanding and lack of interest in supporting the badly needed plant exploration, especially in the tropics where all the problems just described for Veracruz may be even worse. There are countries without even one major herbarium. There are even countries without a plant taxonomist. All the identifications of their plants have to be done elsewhere with great difficulty. The countries with these great problems concerning the identification of their plants are at the same time places of great botanical richness. Their future is based mainly on their plant resources. Yet they don't know what they have, and they do not have the basic facilities to find out. Pressure exist for the conservation of their biodiversity but no efforts exist to help them understand and describe that diversity.

There are many complex issues involved in the conservation of biological diversity. At present we want only to deal with one of these problem issues—but one that does have a practical solution: the identification of the botanical resources.

It seems to us that a major constraint in all the identification processes described above is the lack of more efficient means of access to the species that we already know. If we improve that access, we would also improve the basis for the identification of new species as well as known ones. We would also improve the process of learning more about the species' distribution and abundance and about threats to their existence.

During the development of the *Flora of Veracruz* project, we have become keenly aware of many of these issues (Gómez-Pompa et al., 1985). We have been exploring a variety of non-conventional ways to solve them.

The most promising approach so far is the combination of floristic databases with laser videodiscs. We have developed a demonstration videodisc for the *Flora of Veracruz.* Included among the images on this disc are herbarium specimens, 35 mm slides of *in situ* plants, printed illustrations (pictures, drawings, sketches) and black and white photographs.

Our experience over the past two years with the use and development of this demonstration videodisc have convinced us that optical storage technology will be an extremely useful and economical solution to the problems of plant identification. Most importantly, it is a solution in which developing countries can actively participate.

The importance of images for floras.—Text will always be an important part of floras. Yet the unavoidable technical nature of most botanic descriptions prevent individuals from gleaning much information from the floras without extensive training in the terminology. Even botanists have trouble with descriptive terms used for plants outside of their area of expertise.

Illustrations help immensely in concretize the terminology and the descriptions. Yet illustrations are costly. Scientific illustrators require much time to finish good drawings (especially of species). Because of color separation and printing costs, color pictures are also expensive. This factor of cost limits the number of illustrations most editors of floras are willing to place in their books. Hence choices of what and what not to illustrate have to be made.

Optical Imaging and Data Technology

Laser videodisc technology provides at least a partial solution to these illustrative limitations of printed floras. Videodiscs are a variation of the technology used in audio CD's (Compact Disk) and digital data CD-ROM's (Compact Disk—Read Only Memory). Information is encoded in the linear pattern of tiny precise pits in a transparent material placed just above a reflective layer. A pickup device reads the information from the pattern of reflection of a laser beam aimed at the spiral line of pits.

Laser videodiscs have two properties important for a flora: huge image storage capacity and interactivity. One side of a twelve inch videodisc can hold 54,000 different images (drawings, photographs, microscopy, etc.)—far more than it is reasonable for a book. Each image on the disk can be brought to the screen at will, that is, interactively (by commands to the videodisc player from a computer program or remote unit). Imagine the images one can have together on the same disk for each species in a flora: the plant *in situ,* stem, bark, branches, leaves, veins, stomata, flowers, pollen, fruits, seeds, pollinators, roots, chromosomes, etc. Twenty or thirty or even a hundred images per species would not be unreasonable. Furthermore, motion sequences (not only stills) are a possibility. One could show pollination, seed dispersal, growth (time-elapse photography), etc. This technology adds many exciting potentials to the publications of conventional floras.

Within the existing international standards, the discs have room for analogue and digital sound tracks. This audio capacity can be used for digital data (from 300 to 800 megabytes). So a videodisc can, in addition to the images, contain the programs and database files for understanding the images (see Price, 1986:42 and Atkins, 1985:113).

Comparison with herbaria and books.—Books (with or without illustrations) as well as videodiscs (with or without the massive textual and graphic information capacity of CD-ROM's) are limited surrogates for individual interaction with actual plant communities and human mentors. Such interactions are necessary for "real" understanding of the flora of any area of the world. Even herbarium collections are still only substitutes for such interactions.

But these surrogates have certain advantages over real experience (despite the importance of real experience for understanding the surrogates). Herbarium specimens (herbaria), books (libraries), CD-ROM's, and videodiscs concentrate information within a small area and time frame. They facilitate comparing, questioning, and inquiring, that is, interacting with the information material at hand. They minimize the running from site to site looking at different real plants and ambiences or asking in person this expert or that expert.

Herbarium specimens (real dried plant parts) suffer from limited distribution and availability—though, on the plus side, they have texture and smell. On the other hand, books (that is, traditional floras) are far more available. As with specimens, one can have several of them lying open on the table at the same time. Also like specimens, books require no specialized equipment—beyond adequate vision (or visual aids for the visually handicapped) and lighting. In contrast, the use of videodiscs requires at minimum a videodisc player (an investment of approximately US$1200 at manufacturer-suggested retail prices). But for easy interactive use, one needs to have that videodisc player attached to a computer (a IBM-compatible PC, MacIntosh, Sun workstation, or whatever). The addition of a hard disk, a graphic system (if not supplied in the computer design) or a CD-ROM drive enhances the informational capacity of the interactive system. This equipment can be used with other videodiscs (or CD-ROM's) or for other purposes as well. It does not have to be dedicated to one particular videodisc (or CD-ROM). But it is needed for the use of even one videodisc.

Videodiscs are currently restricted to the resolution of standard video equipment (the 525 NTSC scanning lines in the United States and Latin America or the 625 PAL or SECAM scanning lines in Europe and elsewhere). The video perceptual equivalent of 35 mm film, High Definition Television (from 655 to 2125 scanning lines, though most often 1025 lines), is still far from being a universal commercial fact. Even the best video equipment has far more limited (brightness and color) contrast capacity than color prints (in book floras). The best color printing techniques are not far from color slides in their vividness.

Side-by-side comparisons are hard for videodisc, unless the picture itself is a side-by-side comparison or the system itself has two videodisc players and connnected monitors. Additional hardware devices do allow the digitization and storage of several video images. These digitized images could then be presented side-by-side on a monitor or overlaid upon a video image coming directly from the videodisc player to the video screen. The logistic problems are the same for books: the images have to be side-by-side in the book itself or in different books. Since herbarium specimens are individual items, comparisons are simple if the needed specimens are available.

No single book can match the phenomenal image capacity and access convenience of videodiscs (nor the textual capacity of CD-ROM's). Any image (or action sequence) on a videodisc can quickly be displayed on the monitor through the guidance of computer programming and random accessability of videodisc players: no jumping from book to book nor thumbing through indexes nor glancing at page numbers is required. The image is there when needed and can be quickly replaced by another image appropriate to the interaction between user and information. Videodiscs do have to be changed or flipped if the desired images are available only on another disk and the other side of a disk. Good design can minimize such changing. Jukebox systems, in which discs are mechanically removed and placed in the player, can greatly reduce this problem (but at the cost of additional expense).

Comparison with computer graphics.—Computer graphics is another way of presenting realistic images. There are available graphic systems (monitor and graphic card) which can present high-resolution full color digital images (e.g., 1024 × 768 pixels by 16 million plus colors). Digital images offer many advantages: e.g., manipulability and windowing (displaying more than one image). One main disadvantage is the disk space realistic images an occupy. For example, an image of 512 × 482 pixels by 32,768 colors (a Truevision Targa 16 image file) takes 410,130 bytes (approximately 40% of a megabyte); a VGA image of 640 × 480 pixels by 256 colors occupies 307,987 bytes (approximately 30% of a megabyte). One can place only about 2048 VGA or 1535 Targa images on a 600 megabyte CD-ROM disk (the current highest capacity drive available under a thousand U.S. dollars), far less than the 54,000 on a twelve-inch disk. One can compress the image files, but the file decompression would significantly add to the time it takes to present an image on the monitor screen. The disk space consideration is our main reason for recommending videodisc technology.

Digitalizing a video image from a broadcast-quality videocamera with a videographics card (e.g., the Targa 16) first and then converting it (whether enhanced or not) back into an analogue image for recording on one-inch video tape is a common practice. The resultant image is said to look better than one recorded directly from video camera to one-inch video tape.

Vision of the Uses for a Video Flora

A video flora can be a very powerful tool in the identification of plants. The great advantage is that the identification can be done *in situ.* Several hundred thousands of images of specimens, species and data can be accomodated in a few laser disks. The images and comparisons one needs for identification and understanding can be at one's finger tips in a field station in Veracruz, at a biological reserve in Africa or anywhere electrical power can be made available (through existing lines, gasoline generators or solar panels). The vast amount of information we have on the plants could be readily and inexpensively made available. The present good efforts to have the large historical herbaria stored on microfiche can be surpassed by capturing these specimens on videodiscs. In addition, these disks are by no means limited in use to identification aids. Simply by changing the philosophy of interaction, the same disk can be used for many different purposes including education, basic ecological research, etc.

Steps in creating a video flora.—Let us demonstrate the feasibility of this approach by discussing the tasks involved in a creation of a disk (see Schwartz, 1985; Parsloe, 1985; Price, 1986). First, you have to identify a workable project. The type collections of a herbarium, the collections of a region or a local flora are examples of feasible projects.

Videodisc from master videotape.—Creation of a videodisc is a simple task: take high-quality master videotape(s) to a commercial firm specializing in videodisc production. One has three choices as to the type of videodisc produced (in order of increasing cost): (1) checkdisk, (2) permanent disk, or (3) master disk. Both checkdisks and permanent disks are produced by processes that must be repeated in their entirety for each copy. Checkdisks, as the name implies, are intended as test disks to check the satisfactoriness of both the design and images. They are designed with cheapness, not permanence in mind. They degrade over time (though changing technology keeps increasing their lifetime and video quality). Cost is approximately US$300 for a twelve-inch disk. Permanent disks are made of better materials (e.g., optical glass) that will not degrade through time. Cost is approximately US$1200 (for a twelve-inch disk or $550 for a eight-inch disk). A master disk is designed to be used in the mass production of copies of itself. A twelve-inch master will cost approximately US$2000. Each copy made from that master in that manufacturing run will be from US$9 to $18 a disk (depending on the size of the run). Costs for an eight-inch disk will be correspondingly cheaper (e.g., US$1500 rather than US$2000 for a master).

Economic considerations determine what is a reasonable minimum run. Setup costs for any subsequent run are around US$900. The cost per copy would be the same as for the initial run. For all types of uses of a videodisc (except for a very narrow and closed distribution), the creation of a master disk is the best option.

The major costs are not the actual production of the physical videodiscs. Instead, the production of the master video tape and the gathering of the material constitute the main factors in the final cost of a videodisc production.

The master videotape.—The quality and quantity of this master videotape determines the quality and quantity of the finished videodisc. The factors in that quality and quantity (number of images) is (1) the type of equipment used, and (2) recording method. Obtaining the highest available quality of images requires the use of the most expensive equipment.

One-inch video or Sony Betacam are the current quality standards for commercial broadcast (tens of thousands of dollars). Three-quarter inch video equipment is cheaper (thousands of dollars), but has more quality problems (less color stability, more image shadows, edge effects, etc.). Half-inch video (VHS, Beta or their "super" versions), the home video market standard, is even still cheaper (hundreds of dollars), but has even more quality problems. Given the availability of video sources, one can simply judge for oneself which level of image quality is justifiable for any given purpose and funding level.

Video camera.—One can directly record images on the master video tape through a videocamera. If one needs to reach the capacity of the videodisc for unique images, one needs equipment (e.g., one-inch video or Betacam recorder) that allows single frame recording (or accuracy). If not, one has greater latitude. The three-quarter inch equipment we use to create our eight-inch demonstration videodisc could not do single-frame recording (i.e., positioning). The recorder, however, could be started and then stopped within the minimum of five frames. Each image on our demo disk has therefore on the average five repeats. Instead of 20,780 images (the capacity of an eight-inch disk), there is approximately 4150 images.

Film.—One can also use film (35 mm slides or 16 mm movie film) initially to record the images. Both media have far more image information capacity (color range, brightness range, etc.) than video. Hence, film can function as an excellent image archive. As the commercial resolution and color standards for video increases (e.g., the adoption of High Definition Television), a new master videotape can easily be created from the film archive.

To create that master video tape, one has to transfer the image from the film to video. We simply projected the slides (in our case) upon flat white surface and used a broadcast-quality video camera to record the image(s) on the master videotape. By focusing closeup on different parts of the projected slide image, we created several video images from the same slide. The use of special video equipment, such as the Rank-Cintel Flying Spot Scanner, assures the best results, given the differences in color image capacities. Because of the cost of such equipment, one may have to take the film to a commercial firm for the film-to-video transfer. Rates are approximately US$500 per hour (from a dollar to two dollars per slide).

Still video.—Another option is still video: the video equivalent of a 35 mm film camera, both in size and still picture capacity. The camera and lens are currently much more costly than a 35 mm camera: around $3000 each for a camera body and a special lens. Ordinary 35 mm camera lenses can be used, but one loses automatic white balance and iris control. The light is focused on a CCD chip rather than photographic film and is converted into a video signal by the electronics of the camera. Because of the smaller focus area (the CCD chip rather than film), the lens' functional ranges are greatly enhanced. The individual video frames (i.e., pictures or stills) are recorded on a micro-floppy disk capable of holding 25 full video frames (costing around US$10). These video images, like the film frames, must be transferred to the master video tape. The video signal from a still video floppy reader can be recorded directly on the master tape. Video tape would be the economic storage media for the images. The floppies, like any computer magnetic storage media, can be overwritten and used again.

Computer-created graphics or computer-modified images.—Images generated or modified by a computer can also be used. Certain equipment will transform the image on the monitor of one's personal computer into a composite (NTSC or PAL) video signal. Videographic cards, such as the Truevision NuVista or ATVista, can digitize a video image so that changes can be made (for example, addition of text, arrows, other images, etc.). A series of such images can be created for a motion sequence. The modified digitized image(s) can be converted to a recordable video signal for addition to the master video tape. Graphic computers, such as Pixar, and their software add further possibilities for the illustration of botanical and ecological concepts.

Image considerations: Selection and sources.—The huge image storage capacity of the videodisc is both a blessing and a curse. One can now provide all the images needed to help most individuals understand botanically a certain region, scientific taxon or concept. Yet the acquisition, accounting and the storage of all the images that even the smaller eight inch disc (20,780 unique images) can hold is no small task. When one considers the capacity of one or more twelve-inch disk (54,000 images on one side or 108,000 images on both sides of a disk), the enormity of task is very apparent. One is not required to fill a disk with unique images. One can easily do as we were forced to do with our demonstration disk (use a procedure that produces five duplicates of each image). If a smaller number of images is all that is needed, there is no reason to fill the disk with extraneous images. There is a point, however, at which a smaller number becomes cost-inefficient.

A professional photographer may have shot over a million slides throughout his or her lifetime (e.g., Marc Garanger, 1989). A botanist can easily have thousands of slides—even 54,000 or more in his or her lifetime collection. In a sense, 54,000 is not all that many. Yet an individual's slide collection may not, in fact, make a good video flora.

The intent of a video flora is to provide an understanding of the flora in a certain region not only for the expert quite well versed in the plants there, but also for the individual not so familiar as well as the interested non-botanist. That is, the pictures have to be selected to convene a systematic understanding of each plant to an individual who has not seen that particular plant before. There can be no gaps nor assumed experience. Since contrast (and similarity) is important for identification as well as general understanding, there has to be pictures available to show the contrasts (and similarities) in each characteristic for the various species, subspecies, varieties and forms. For example, the petioles, pollen, seeds, chromosomes, etc., of each must be shown in a way that the contrast and similarity is evident. Closeups and midrange shots may have to be included as well as dissection shots. Slides and drawings to enhance certain aspects may have to be intertwined.

The various states of the plant through its life cycle and the seasons should be shown as well. The dry and standing remains of annuals are common forms found in the field. Including pictures of both the desiccated and the live forms helps with identification. By including images of different individuals within a population, a feel for the biological diversity within a species population can be conveyed.

Besides the physical specimens, a videoflora may depict drawings of habitat characteristics (vegetation types, ecological zones, plant communities) and/or botanical characters (such as leaf, flower, fruit, and seed).

Given these requirements, the acquisition of images becomes far more complex. It is more than showing one's slide collection. A video flora will always ideally be a cooperative effort. Images from various sources (specialists, fellow botanists, etc.) can be gathered as well as slides and other images specifically made for the video flora.

Recordkeeping.—Recording information about each image (whether used in the final videodisc or not) into a computer database is essential for quick and efficient production of the video flora. One obvious bit of information is the identification of the image (the scientific name of the plant, the location of a landscape, the subject matter of a drawing, etc.). Other important information is: the source of the image, details regarding its creation (time, location, method, creator, etc.), nature of the view, relation with other images, and so forth.

A very important detail is the image's place in the sequence of images on the master videotape. The videodisc player references an image on a disk only by its frame number (that is, its sequence number). The image at frame number ten is the tenth image on the disk. To bring up that image at will (yours or the computer's) requires having its frame number. The order in which the images are entered into the master videotape is the order of the final videodisc.

One can wait until the final videodisc is finished to begin to create this database. Or one can begin the database at the initial planning and image gathering. The database can be designed to insure the completeness of images for each species and concept (for example, noting if leaf shape has been graphically illustrated for each pertinent species).

This database provides the basis for the computer applications using the videodisc: plant identification, plant resource management, floristic research, etc. If you need a list of images illustrating a particular concept (for example, shade adaptation or a certain plant community), you need only query the database. The computer application can query the whole database directly or a subset specialized for its particular purpose.

Computer programming.—The interfacing between computer and videodisc player is not a serious computer programming challenge. The player accepts ASCII commands and returns ASCII codes through a port (usually serial).

The challenge lies in providing a user interface that allows the user the freedom to explore the images on his or her own. People need quick, easy and self-initiated comparisons between images for understanding. The user should be able to pick his or her own list of images for quick and easy comparison. Even with application-generated lists of images (for example, leaves of the species of a genus), the user should have a choice of what images to see and compare.

The solution.—We see videodiscs as an ideal solution for the crisis in plant identification for the following reasons:

1) the cost and resources for producing satisfactory video floras are within the capacity of most countries of the world and the agencies and foundations funding natural conservation and resource management,
2) the cost of equipment (videodisc players, CD-ROM drives and even IBM-compatible or MacIntosh computers, if necessary) needed for the research institutes is also within the funding capacity of most world conservation agencies and foundations, not to mention, governments, and
3) the costs of use are easily within the capacity of most relevant organizations and institutes.

One can spend a lot of money producing a videodisc (and accompanying computer program). The Danish videodisc project SIULLEQ (Pring, 1989) is budgeted for DDK 12.1 million (US$1.7 million). The British videodisc project DOMESDAY (Atkins, 1985) was a national effort. But one is not required to spend so much. There are many cost-cutting labor options available to academic (versus commercial) projects, e.g., the non-commercial nature of academic information exchange (including images), use of university media resources (at no or minimum charge). The volunteer collaboration of academic colleagues in terms of images and information can lower costs significantly over a pure commercial venture. One can also cut costs by relying on the satisfactory, but cheaper methods of image transfer to video tape. One does not need the best available (and costly) image quality to have a satisfying video flora. An example of an excellent but inexpensive (money-wise) videodisc project is Michael Hamilton's Macroscope Ecology Laserdisc (Fenton, 1989; Hamilton and Lassoie, 1986).

Access to the technical equipment is limited only for the actual physical creation of the videodisc. The manufacturing facilities for videodisc are not widely located through the world. The major firms are currently located only in Europe, United States, and Japan.

However, access to the technical equipment for the creation of the master video tape is far less limited. Video facilities are widely distributed throughout the world as are color film development facilities. Most countries of the world have national television stations. Collaboration between academic and research institutions can widen access to the technical equipment and expertise. Whether individual botanists or research institutes can always develop a cooperative relationship with their respective national television broadcast system is a question we can not answer. But there are many examples in Europe of national broadcast systems helping with videodisc productions (as mentioned above-the British Broadcast Corporation's Domesday and Aquatic Life videodiscs and the Danish Radio Interactive Video Project's SIULLEQ Greenland disc).

A technical problem for international video projects (such as future video floras) is posed by different national or regional technical standards: in this case, NTSC, PAL, and SECAM. NTSC (National Television Systems Committee) television standards hold sway through United States and most of Latin America. PAL (Phrase Alteration Line) is the standard for Europe, Africa, and Asia, while SECAM (Sequential Couleur A Memoire) is used in France and the Soviet Union. There are video tape players that are switchable, that is, that can play tapes of different standards. But as far as we can tell, no one has manufactured a bi- or tri-standard videodisc player. One can produce a disc with both standards but on different sides of the disc. The costs are, of course, higher for such a solution. Furthermore, video equipment in a given country is usually uniformly either PAL or NTSC. The equipment for conversion of videotapes between video standards is only limitedly available. The conversion service charges are high. Such consideration limits the exchange of video images. The cheapest long-term solution is encouraging the manufacturing of switchable videodisc players and an universal standard for high definition television (such standards exist for CD's, CD-ROM's, and erasable optical disks).

It seems to us that video floras have a great potential for stimulating botanical exploration in the developing world. Also such floras have enormous potential as an educational tool. Finally they would be a powerful tool in plant research. It may open the possibility of having electronic herbaria providing access to information from everywhere through video disks (and CD-ROM's) in remote places for a small investment (US$3–5000). The challenge is getting the acceptance of this approach by the botanical community and by the grant agencies so that video flora projects can be encouraged, supported and funded.

Finally, this approach has many applications beyond the botanical uses mentioned above. We have been developing a computer-friendly interactive video program for educational purposes that uses images of plants and environments with textual and geographical databases to explore at many levels the diversity of plants. This interactive video approach is an excellent way to introduce students of all levels to the excitement of the study of biodiversity. It could also be a very powerful tool for conservation. We have developed a video tape showing different applications of this approach that we call Q'TAXA. Any interested person may obtain a copy for the cost of the tape and mailing.

Acknowledgments

We would like to acknowledge the support for this project from International Union for the Conservation of Nature (IUCN), Conservation International, and the UCR–Mexico Collaborative Program. We would also wish to thank David B. Kronenfeld for his comments and suggestions for early drafts of this paper.

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