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BOOK REVIEW

PAPER FLORAS: HOW LONG WILL THEY LAST? A REVIEW OF *FLOWERING PLANTS OF THE NEOTROPICS*[1]

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Flowering Plants of the Neotropics compiled and edited by a team of leading botanists at the New York Botanical Garden (Smith et al., 2004) is magnificently illustrated and rich in authoritative data about the 284 native families of tropical angiosperms currently found in the Western Hemisphere. Compiling information from over 150 contributors and specialists on various groups of plants was clearly a task of significant dimension and the authors are to be congratulated for their contribution to the literature on neotropical flowering plants. This volume follows on the heels of other contemporary contributions to this subject, such as Maas and Westra's (1998) more modest treatment on neotropical plant families, Al Gentry's (1996) wide ranging and highly idiosyncratic tome on plants of northwestern South America (also widely applicable throughout the neotropics), the very detailed field guide to the plants of the Ducke Reserve near Manaus in Amazonian Brazil (similarly of considerable value throughout the Amazon Basin), and finally the ''in progress'' manual of plants of Costa Rica orchestrated by Hammel, Grayum, Herrera and Zamora (2003) that will serve as the gold standard for national tropical floras when completed. These publications collectively tell us that we know a surprising and considerable amount about the flowering plants of the tropical Americas.

This most recent contribution by Smith and colleagues (2004) hovers between a taxonomic monograph and a typical flora in that on the one hand it provides an in-depth treatment of a specific monophyletic group of plants (the angiosperms), but on the other it is restricted in scope to only those taxa found in a distinct geographic region, the neotropics. All things being considered one would have to categorize this broad-based reference volume as a family-level flora of the neotropics. In general we use floras for the purposes of inventory (knowing what taxa are present in an area), identification (knowing the names of the taxa we find or study), description (knowing more about the taxa than we currently do), and classification (knowing how taxa are related to other taxa within as well as outside the focal region). Published floras (as those cited above) vary in their success in providing information in each of these four categories.

How does *Flowering Plants of the Neotropics* compete as a flora with respect to these criteria? The authors have done a great job in the first three categories (inventory, identification, and description), but have partially failed in the fourth (classification). The work is quite comprehensive in the inclusion of all 284 families that have any native taxa represented in the neotropics as well as important introduced species and cultivars. The keys (grouped in an appendix) and illustrations (including 308 color photographs and 258 black and white line drawings) together provide a generally reliable means of identification of plants to family and in some cases to genera (although a few seem misplaced, e.g., *Piriqueta* for *Turnera*) and even species (as far as I have been able to attempt although I haven't used it extensively yet in the field for reasons noted below). For each family treatment we are provided with information and notes on critical morphological features, taxonomic diversity, distribution and habitat, classification, natural history, and ethnobiologial uses; some critical literature references are also included. These data provide a wealth of information about each family that allows the reader to put the particular plant family into an ecological, geographical, and economic framework. The extensive illustrated glossary is a luxury.

And if one wants to know how Arthur Cronquist (1981) and Rolf Dahlgren (and colleagues; 1985), two renowned but now deceased authorities on angiosperm classification, circumscribed and classified neotropical dicot and monocot families, respectively, then the co-editors might consider that they have succeeded in the fourth purpose of floras as well. This last point identifies one of the most curious, and perhaps disappointing, aspects of the volume. In the age of molecular systematics and the growing acceptance of a new consensus classification of the flowering plants by the Angiosperm Phylogeny Group (1998, 2003; hereafter APG), why have Smith and co-editors regressed to the classifications and circumscriptions of Cronquist and Dahlgren? They claim that using the older systems makes ''identification of neotropical plants to family a great deal easier.''

But does it? Or is it just easier for those who have used these former systems for two decades? And if that is the case, why not go back to Engler and Prantl's (1887–1915) system which has been effectively used for a century? Admittedly, the APG, which has in large part resulted from new insights about relationships gained from DNA sequence data, recognizes a number of segregate families, e.g., in the lilioid monocots, and aggregate families, e.g., the Malvaceae sensu lato, that are defined by anatomical, biochemical, and developmental characters, but lack easily distinguishable diagnostic morphological features useful in identification. However, only when we start working within the framework of a new classification will we ever discover new characters and new relationships to use for such purposes. The co-editors state that they wish ''to provide

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a book reflecting current knowledge of the flowering plants of the neotropics that can be used by amateur and professional biologists alike.'' Unfortunately they have missed a real opportunity to provide the first comprehensive family flora of the neotropics based on an up-to-date and modern classification system.

If this volume were a real field guide (but at over 600 pages and 2.7 kilos it is not) with the primary purpose of identification, then there might be more justification for simply following an old system of classification. But since this book will be primarily used in the classroom and herbarium as a primary reference tool, there is no excuse to follow an outmoded system of classification. I predict that this book will find itself mostly on the bookshelves of botanists in their offices, herbaria, and even tropical field stations and will be referred to when someone wants to know more about a plant that they have already determined to be in a specific family. I truly doubt that anyone is going to carry this tome in their backpack solely to identify to family-level unknown plants found in the field in the neotropics. The co-editors do provide an appendix for cross-referencing the Cronquist and Dahlgren family circumscriptions to the classification used by Judd et al. (2002; slightly different than the APG taxa), but they would have been better advised to organize the book by APG with cross-reference to the classifications of Cronquist, Dahlgren, and even Engler and Prantl. The alphabetical organization of the family treatments (and the photographs) within the dicots and the monocots is also irritating if one wants to easily compare closely related families (see Funk, 2003).

One of my biggest suggestions, which has been echoed by a number of others who have also used this book, would be to make the information on these neotropical plant families more portable via an electronic version. The beautiful production of the book with both excellent line drawings and color photographic representatives of each family would lend itself to reformatting into a very useful compact disc version, thus greatly enhancing its portability and use away from the office, lab, herbarium, or library. Although I suspect that many botanists would not carry this book on a field trip or even with them to visit foreign herbaria, almost all of us do carry our laptops and personal digital assistants (PDA) packed with various reference materials. A handy version that could be downloaded to either of these formats would increase by a magnitude (if not two!) the usefulness and accessibility of the information contained in *Flowering Plants of the Neotropics.* If available in this format, I would then certainly carry the information with me whenever I travel to the field or to herbaria in the neotropics.

If this volume were available electronically, I suspect that it also would have the potential to be used in an entirely different, and potentially more useful, fashion than the paper hard copy. Electronic field keys, searchable descriptions with key characters, and digital images with high resolution and magnification capabilities are just a few electronic features that would certainly have to be added. With such new features available one can start to imagine what *Flowering Plants of the Neotropics* would look like if it was published in 2024 rather than 2004. This latter point suggests a broader, more universal question about such botanical works: What will the floras of the future look like and what will they do that they don't or can't do today? Will there even be a need for floras in the year 2024 when the ''Encyclopedia of Life'' is completed (Wilson, 2003)? In fact what will field taxonomists be doing in 20 years? Answers to these questions will determine how books such as this one will be used in the future and thus how they will be constructed.

In the age of bioinformatics, field taxonomists of the future exploring the remaining natural habitats on the planet must have immediate access to the vast store of biodiversity information now contained in our libraries, museums, and botanical gardens (Bisby, 2000; Edwards et al., 2000). One can envision that in the next half century during what will probably be the final great age of biological exploration the electronic naturalist will be equipped with new technologies to enhance and accelerate his/her work, including micro-global positioning systems, palm-top computers, web-based satellite communication, and mini-DNA samplers and sequencers (Wilson, 2000; Kress, 2002; Kress and Krupnick, 2005). The plant explorers of the future will comb the remaining semi-pristine habitats of the Earth identifying and recording the characters and habitats of plant species not yet known to science. With remote wireless communication the field botanist will be able to immediately compare newly collected plants with type specimens and reference collections archived and digitized in museums thousands of miles away. The information gathered by these botanists will be sent with unimaginable speed to their colleagues back in the lab where the genetic composition and phylogenetic position of each new species will be immediately determined. The habitat data will be modeled with unparalleled accuracy by super computers to determine the place of each species in its respective ecosystem. And the biochemical constituents of each species will be automatically screened and analyzed for any compounds that may be of benefit to society. This vision of discovering and describing the complete natural world is already becoming a reality through the partnership of natural history biologists, computer scientists, nanotechnologists, and bioinformaticists (Wilson, 2003).

Although parts of this vision are fantasy and may be such for the foreseeable future, accelerating the collection and cataloguing of new specimens in the field is not. Augmenting this task is critical for the future documentation of biodiversity particularly as the race narrows between species discovery and species lost due to habitat destruction. New technologies are now being developed to greatly facilitate the coupling of field work in remote locations with ready access and utilization of data about plants that already exist as databases in biodiversity institutions, such as herbaria, natural history museums, and botanical gardens. Specifically a taxonomist who is on a field expedition should be able to readily access via wireless communication through a laptop computer or ''PDA-on-steroids'' critical comparative information on plant species that would allow him/her 1) to quickly identify the plant in question through electronic keys and/or character recognition routines, 2) to determine if the plant is new to science, 3) to ascertain what information, if any, currently exists about this taxon (e.g., descriptions, distributions, photographs, herbarium and spirit-fixed specimens, living material, DNA tissue samples and sequences, etc.), 4) to determine what additional data should be recorded (e.g., colors, textures, measurements, etc.), and 5) to instantaneously query and provide information to international taxonomic specialists about the plant. Providing these data directly and effectively to field taxonomists and collectors would greatly accelerate the inventory of plants throughout the tropics and greatly facilitate their protection and conservation as well.

Electronic keys and field guides are nothing new and have been available since computers began processing data on morphological characteristics (Pankhurst, 1991; Edwards and Morse, 1995; Stevenson et al., 2003). In the simplest cases, standard word-based field keys using descriptive couplets have been enhanced with color images and turned into electronic files to make identification of known taxa easier and faster. More sophisticated versions include electronic keys created through character databases (e.g., Delta, Lucid). Some of these electronic field guides will soon be available on-line or for downloading onto PDAs (e.g., Heidorn, 2001; OpenKey: http://www3.isrl.uiuc.edu/~pheidorn/cgi-bin/schoolfieldguide.cgi) while others are been developed as active websites (e.g., Flora of the Hawaiian Islands: http://ravenel.si.edu/botany/pacificislandbiodiversity/hawaiianflora/index.htm).

At the Smithsonian in collaboration with computer scientists at the University of Maryland and Columbia University we are taking the next step in electronic field guides by developing plant image recognition software and hardware that will automatically provide identifications based on digital images of the plants. Our prototype will use textual information and digitized images of our approximately 93 000 type specimens at the U.S. National Herbarium to develop a species library to match specimens collected in the field. Eventually we will incorporate into the library specimen images that represent all known vascular plant species. Although we have started with simple visual recognition allowing the taxonomist to manually compare the plant in hand with specimen images in the library, the goal is to develop a computer-based image recognition algorithm that will automatically and rapidly match a digitized image of the field collection with the correctly identified herbarium specimen image comparing characters such as leaf shape, margins, venation, and surface textures. The image comparisons will eventually extend to flower, fruit, seed, and even root characters if they are necessary for identification. These algorithms will incorporate methods that compare pairs of images using template and deformable template matching, methods that take advantage of multiple images of a species to model the variation of appearance in different plants as low-dimensional subspaces, and methods that recognize plants using 3D models to gain maximum invariance to pose and lighting changes (Debevec et al., 1996; McMillan and Bishop, 1995; Ramamoorthi and Hanrahan, 2001; Wood et al., 2000; Yu et al., 1999). Ultimately once the correct identification match is made, the taxonomist will be immediately linked with all of the information contained in the reference library for that species. The non-trivial problem associated with natural variation in form presents the biggest challenge to successfully implementing this system. The final phase of the project will be to develop a series of devices with mobile user interfaces to be tested and eventually used in the field. We expect to have the prototype ready for field trials within four years time. To build this second generation electronic field guide it will be necessary to harness the collective power of herbarium specimens, digital images, computer vision, computer graphics modeling, visual databases, mobile user interfaces, and wireless data transmission.

In parallel to this system of rapid plant identification based on computerized image recognition systems, others are developing a DNA-based technique to accomplish the same goal. The term ''DNA barcoding'' has been applied to this species identification system that has already proved successful in limited trials on animals (Holmes, 2004). The use of short DNA sequences for biological identifications was first proposed by Herbert et al. (2003a, b), with the ultimate goal of quick and reliable species-level identifications across all domains of life (Blaxter, 2003). These ideas have been propelled by animal systems, although the usefulness and practicality of such approaches have been long accepted for microorganisms (usually with rDNA) for which morphological data is limiting or difficult to obtain. Plants have been notably absent during early discussions for the Consortium for the Barcode of Life initiative (http://barcoding.si.edu) and until recently no plant pilot projects have been suggested (Stoeckle, 2003). However, the utility of small-scale DNA barcoding approaches in plants has already been demonstrated in a few cases where traditional methods have failed for identifications, such as in extinct herbivore diets (Poinar et al., 1998; Hofreiter et al., 2000), for roots growing in Texas caves (Jackson et al., 1999), and for species used in herbal supplements (Zerega et al., 2002). Developing an easy and efficient assay for quick plant identifications using the DNA barcoding model is not far off (K. Wurdack, E. Zimmer, and L. Weigt, personal communication).

As with the introduction of any new method of analyses in science some controversy and concern has arisen about the feasibility and utility of DNA barcoding in taxonomy (Holmes, 2004). A number of taxonomists appear to be opposed to new methodologies that may further the ''Linnaean enterprise'' (i.e., inventory, identification, and classification of life), but threaten the field of taxonomy. Some are particularly concerned that new technologies might be substituted for the taxonomic specialists doing their job working directly with specimens. Others believe that these new techniques will be misused and give faulty results. These misconceptions arise for a number of reasons with DNA barcoding, such as 1) equating DNA barcoding with DNA taxonomy, which it is not (Seberg et al., 2003); 2) equating ''service identifications'' through DNA barcoding with the entire field of taxonomy when it is only one aspect of what we do as taxonomists (Lipscomb et al., 2003); 3) confusing the use of DNA barcoding as a means to reconstruct phylogenies when it is really a tool strictly for identification purposes (e.g., Will and Rubinoff, 2004); and 4) believing that any new tool, such as DNA barcoding, will replace the need for taxonomic specialists or at least siphon off all of their funds and professional positions (Scotland et al., 2003). None of these conceptions is true. The first and second will be resolved when DNA barcoding is understood to be one tool of many on the taxonomist's work bench that in most cases, but not all, will facilitate identification. The third will be clarified when DNA barcoding is shown to actually work in identification of the majority of species to which it is applied even though it may fail for phylogenetic purposes. The fourth misconception will be more difficult to overcome even though it could not be further from the truth. In fact, the easier it is for end-users to employ good taxonomic data for identification, i.e., through systems such as web-based floras and rapid DNA barcoding, the more the field of taxonomy and taxonomists will be appreciated for their skills and knowledge by the scientific community as well as the lay public. Public interest in Nature, biodiversity, and the environment by non-professionals is soaring and the demand for effective field guides that provide correct and easy identification of species is at an all time high (Gorman, 2004; Janzen, 2004, 2005). If more taxonomic information is available to the non-specialist to use for species identifications, then the more appreciation and respect will be accorded to the taxonomist who supplied that information from the start. And in the long run, respect for Nature will proportionally increase.

In conclusion, *Flowering Plants of the Neotropics* is a wonderful floristic compendium of information at the family-level for plants found in tropical America, but its usefulness is compromised in part due to its organization based on an out-dated system of family circumscription and classification as well as its publication in traditional hard-copy format only. The floras of the future, including web-based, computer-based, image-based, and even DNA-based products, are already taking on new forms and fulfilling new functions that paper-based and word-based floras of the past could never attain. As speciation events are outpaced by species extinction events over the next century, the number of taxa included in these floras may unfortunately and regrettably decline just as our ability and tools to identify, understand, and appreciate them expand.

LITERATURE CITED

ANGIOSPERM PHYLOGENY GROUP [APG]. 1998. An ordinal classification for the families of flowering plants. *Annals of the Missouri Botanical Garden* 85:531–43.

ANGIOSPERM PHYLOGENY GROUP [APG II]. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of Linnean Society* 141:399–436.

BISBY, F. A. 2000. The quite revolution: biodiversity informatics and the Internet. *Science* 289:2309–2312.

BLAXTER, M. 2003. Counting angels with DNA. *Nature* 421:122–123.

CRONQUIST, A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.

DAHLGREN, R. M. T., H. T. CLIFFORD, AND P. F. YEO. 1985. The families of the monocotyledons. Springer-Verlag, Berlin.

DEBEVEC, P., C. TAYLOR, AND J. MALIK. 1996. Modeling and rendering architecture from photographs: a hybrid geometry and image-based approach. *SIGGRAPH* 96:11–20.

EDWARDS, J. L., M. A. LANE, AND E. S. NIELSEN. 2000. Interoperability of biodiversity databases: biodiversity information on every desktop. *Science* 289:2312–2314.

EDWARDS, M., AND D. R. MORSE. 1995. The potential for computer-aided identification in biodiversity research. *Trends in Ecology and Evolution* 10:153–158.

ENGLER, A., AND K. PRANTL. 1887–1915. Die Naturlichen Pflanzenfamilien. Wilhelm Engelmann, Leipzig, Germany.

FUNK, V. A. 2003. Down with alphabetically arranged herbaria (and alphabetically arranged floras too for that matter). *Plant Science Bulletin* 49: 131–132.

GENTRY, A. H. 1993. A field guide to the families and genera of woody plants of northwest South America (Colombia, Ecuador, Peru). University of Chicago Press, Chicago, Illinois.

GORMAN, J. 2004. So many field guides you need a guide. *The New York Times,* July 20, p. D3.

HAMMEL, B. E., M. H. GRAYUM, C. HERRERA, AND N. ZAMORA [EDS.]. 2003. Manual de plantas de Costa Rica. Volumen II. *Monographs in Systematic Botany from the Missouri Botanical Garden* 92:1–694.

HEIDORN, P. B. 2001. A tool for multipurpose use of online flora and fauna: the Biological Information Browsing Environment (BIBE). *First Monday* 6: 2. http://firstmonday.org/issues/issue6_2/heidorn/index.html.

HERBERT, P. D. N., A. CYWINSKA, S. L. BALL, AND J. R. DEWAARD. 2003a. Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London, Series B* 270:313–321.

HERBERT, P. D. N., S. RATNASINGHAM, AND J. R. DEWAARD. 2003b. Barcoding animal life: cytochrome *c* oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society of London, Series B* 270 (suppl.):S96–S99.

HOFREITER, M., H. N. POINAR, W. G. SPAULDING, K. BAUER, P. S. MARTIN, G. POSSNERT, AND S. PÄÄBO. 2000. A molecular analysis of ground sloth diet through the last glaciation. *Molecular Ecology* 9:1975–1984.

HOLMES, R. 2004. Barcode me. *NewScientist* 26 June, 32–35.

JACKSON, R. B., L. A. MOORE, W. A. HOFFMANN, W. T. POCKMAN, AND C. R. LINDER. 1999. Ecosystem rooting depth determined with caves and DNA. *Proceedings of the National Academy of Sciences, USA* 96:11387–11392.

JANZEN, D. H. 2004. Now is the time. *Philosophical Transactions of the Royal Society of London, B DOI* 10.1098/rstb.2003.1444.

JANZEN, D. H. 2005. Foreword: how to conserve wild plants? Give the world the power to read them. *In* G. A. Krupnick and W. J. Kress [eds.], Plant conservation: a natural history approach. University of Chicago Press, Chicago, Illinois. (in press).

JUDD, W. S., C. S. CAMPBELL, E. A. KELLOGG, P. F. STEVENS, AND M. J. DONOGHUE. 2002. Plant systematics: a phylogenetic approach. Sinauer Associates, Inc., Sunderland, Massachusetts, U.S.A.

KRESS, W. J. 2002. Globalization and botanical inventory. *In* T. Watanabe, A. Takano, M. S. Bista, and H. K. Saiju [eds.], Proceedings of the Nepal-Japan Joint Symposium on ''The Himalayan plants, Can they save us?'' 6–8. Kathmandu, Nepal. Society for the Conservation and Development of Himalayan Medicinal Resources, Tokyo, Japan.

KRESS, W. J., AND G. A. KRUPNICK. 2005. Documenting and conserving plant diversity: the future. *In* G. A. Krupnick and W. J. Kress [eds.], Plant conservation: a natural history approach. University of Chicago Press, Chicago, Illinois. (in press).

LIPSCOMB, D., N. PLATNICK, AND Q. WHEELER. 2003. The intellectual content of taxonomy: a comment on DNA taxonomy. *Trends in Ecology and Evolution* 18:65–66.

MAAS, P. J. M., AND Y. TH. WESTRA. 1998. Neotropical plant families: a concise guide to families of vascular plants in the neotropics, 2nd ed. Koeltz Scientific Books, Koenigstein, Germany.

MCMILLAN, L., AND G. BISHOP. 1995. Plenoptic modeling: an image-based rendering system. *SIGGRAPH* 95:39–46.

PANKHURST, R. J. 1991. Practical taxonomic computing. Cambridge University Press, Cambridge, UK.

POINAR, H. N., M. HOFREITER, W. G. SPAULDING, P. S. MARTIN, B. A. STANKIEWICZ, H. BLAND, R. P. EVERSHED, G. POSSNERT, AND S. PÄÄBO. 1998. Molecular coproscopy: dung and diet of the extinct ground sloth *Nothrotheriops shastensis*. *Science* 281:402–406.

RAMAMOORTHI, R., AND P. HANRAHAN. 2001. A signal-processing framework for inverse rendering. *SIGGRAPH* 01:117–128.

RIBEIRO, J. E. DA S., M. J. G. HOPKINS, A. VICENTINI, C. A. SOTHERS, AND M. A. DA S. COSTA, ET AL. 1999. Flora da Reserva Ducke. Guia de identificação das plantas vasculares de uma floresta de terra-firme na Amazônia central. INPA, Manaus, Brazil.

SCOTLAND, R., C. HUGHES, D. BAILEY, AND A. WORTLEY. 2003. The Big Machine and the much-aligned taxonomist. *Systematics and Biodiversity* 1:139–143.

SEBERG, O., C. J. HUMPHRIES, S. KNAPP, D. W. STEVENSON, G. PETERSON, N. SCHARFF, AND N. M. ANDERSEN. 2003. Shortcuts in systematics? A commentary on DNA-based taxonomy. *Trends in Ecology and Evolution* 18:63–65.

SMITH, N., S. A. MORI, A. HENDERSON, D. WM. STEVENSON, AND S. V. HEALD [EDS.]. 2004. Flowering plants of the neotropics. Princeton University Press, Princeton, New Jersey.

STEVENSON, R. D., W. A. HABER, AND R. A. MORRISS. 2003. Electronic field guides and user communities in the eco-informatics revolution. *Conservation Ecology* 7: 3. http://www.consecol.org/vol7/iss1/art3.

STOECKLE, M. 2003. Taxonomy, DNA, and the bar code of life. *BioScience* 53:796–797.

WILL, K. W., AND D. RUBINOFF. 2004. Myth of the molecule: DNA barcodes for species cannot replace morphology for identification and classification. *Cladistics* 20:47–55.

WILSON, E. O. 2000. A global biodiversity map. *Science* 289:2279.

WILSON, E. O. 2003. The encyclopedia of life. *Trends in Ecology and Evolution* 18:77–80.

WOOD, D., D. AZUMA, K. ALDINGER, B. CURLESS, T. DUCHAMP, D. SALESIN, AND W. STUETZLE. 2000. Surface light fields for 3D photography. *SIGGRAPH* 00:287–296.

YU, Y., P. DEBEVEC, J. MALIK, AND T. HAWKINS. 1999. Inverse global illumination: recovering reflectance models of real scenes from photographs. *SIGGRAPH* 99:215–224.

ZEREGA, N. J. C., S. MORI, C. LINDQVIST, Q. ZHENG, AND T. J. MOTLEY. 2002. Using amplified fragment length polymorphisms (AFLP) to identify black cohosh (*Actaea racemosa*). *Economic Botany* 56:154–164.