Book Reviews

Books Reviewed

Developmental and Structural

Atlas of Stem Anatomy in Herbs, Shrubs and Trees.

Schweingruber, F., A. Börner, and S. Ernst-Detlef. 2011. Vol. 1.
(Cloth US$139) 495 pp. Springer, Heidelberg. pp. 495.

This remarkable book is the first of two volumes that represent the fruit over 40 years work by Fritz Schweingruber on the stem anatomy of dicotyledonous herbs, shrubs and trees. It represents a monumental effort to document stem anatomy across a wide range of dicotyledonous, and to make this information accessible for future generations. The first volume covers the Magnoiliids and Eudicots, but excludes most of the Asterids which are covered in the forthcoming Vol. 2. I emphasize the accessibility of the work because the presentation of this research extends beyond the physical volumes published by Springer to the online Xylem Database and accompanying data tables, parts of which predate the publication of the book (Schweingruber and Landolt, 2005-2010). I will return to a discussion of these online resources after reviewing the book.

The Atlas differs from the Anatomy of the Dicotyledons (Metcalfe and Chalk, 1983) in several important respects. First, although some taxa without secondary growth are included in the Atlas, the emphasis is on those with secondary growth. This is not to say that all of the study species are "woody" in a traditional sense, as many would have been classified as "herbaceous" before the production of this work. In fact, many so-called herbaceous plants produce at least some secondary growth, and sometimes have abundant secondary growth (Dulin and Kirchoff, 2010). For instance, individuals of Arenaria biflora (Caryophyllaceae) in the alpine and sub-alpine zones have been found with up to 43 annual rings. Clearly, this is no ordinary herb. As long as we restrict ourselves to a simplistic understanding of plant growth that divides plants into those with secondary growth (woody plants) and those without (herbs), we will never understand the full range of plant growth forms, or be able to realistically relate these growth forms to anatomical structures. Sherwin Carlquist has been making this point for years with respect to shrubby, suffrutescent, pachycaulous, and lianoid growth growth forms (Carlquist, 1962, 2001). The Atlas extends this work to cover so-called herbaceous plants, while confirming and enlarging our knowledge of stem anatomy in shrubs and trees.

The book's use of standardized character descriptions leads to the second difference with the Anatomy of the Dicotyledons. The authors use, and extend, the International Association of Wood Anatomist's (IAWA) character definitions (a type of controlled vocabulary) to describe the structure of the xylem (Wheeler et al., 1989), and produce their

own standard characters for the description of the bark. Though my co-authors and I have pointed out the limitations of controlled vocabularies when used across wide ranges of taxa and structures (Kirchoff et al., 2008), I believe controlled vocabularies have a place of when their domain of applicability can be clearly circumscribed, such as in the description of wood. In most cases the wood anatomical structures described in the Atlas are relatively homogeneous, at least with respect to the wide range of variation in structures one finds in, for instance, flower structure across the angiosperms. There may be disagreements about the best way to describe a libriform fiber, or the degree of vessel size difference must be present between the early and latewood for the wood to be called ring porous, but these types of discrepancies pale in comparison to the difficulties encountered when trying to find a single set of terms that allow the determination of homologies between flowers as diverse as those of Euphorbia and Magnolia (Kirchoff et al., 2008).

If controlled vocabularies are to be used, they are best when each term is illustrated, preferably with multiple examples (Leggett and Kirchoff, 2011). The original IAWA term descriptions employ this practice to good effect (Wheeler et al., 1989), and the Atlas follows the same example, improving on it in some ways. Approximately 20 pages at the front of the Atlas are devoted to illustrated definitions of technical characters. Using the IAWA classification as a starting point, the authors extend the characters to take new data into account. For instance, Character 2 in the IAWA classification is "Growth ring boundaries indistinct or absent," but this character definition does not differentiate between annual plants with second growth, and plants with no secondary growth. Both types of plants are covered in the Atlas. Because of this, the authors create two new sub-characters (character states): 2.1 "Only one ring (Annual plants)" and 2.2 "Without secondary growth." Character 2.1 is illustrated with 12 photographs, while Character 2.2 is illustrated with six.[1] I am pleased to see this use of multiple illustrations, as my colleagues and I have advocated the use of multiple photographs to document character and character state variation (Kirchoff et al., 2007; Kirchoff et al., 2011; Leggett and Kirchoff, 2011). When multiple illustrations are used in this way, problems with interpreting the meaning of the verbally defined characters are mitigated (Stevens, 1991). In addition to Character 2, many of the other IAWA characters are also refined for use in the Atlas. In this way, the Atlas serves not just as a repository of anatomical descriptions, but also as an updated character and character state reference, similar to the original IAWA publication (Wheeler et al., 1989).

The heart of the Atlas consists of xylem and bark anatomical descriptions arranged by family. Each family chapter begins with a brief summary of the number of species studied, the life forms of the species, and the vegetation zones in which they are found. The opening page also contains representative images of the study species. The body of each chapter consists of lavishly illustrated descriptions of the characteristics of the xylem, and of the phloem and cortex of the covered species. If ecological trends emerged from the study, then these are noted in a separate section. There is also a brief discussion of the previous literature on xylem and bark anatomy of the family. Each chapter ends with a frequency table of characters found in the family. For instance, of the 161 species of the Brassicaceae that are investigated 105 had growth rings that were distinct and recognizable (character 1), 18 had growth rings there are indistinct or absent (character 2), and 36 had only one ring (character 2.1). The astute reader will notice that this tabulation leaves two species unaccounted for. It also leaves open the question of how many of the 18 species that have growth rings that are indistinct or absent also lack secondary growth (character 2.2, which does not appear in the table). These types of discrepancies are perhaps inevitable when dealing with huge data sets like this, though they are always frustrating and one hopes that the authors have taken every precaution to minimize them.

Before going on to some limitations and technical problems with the Atlas, I want to return to the Xylem Database and its downloadable list of anatomical features (Schweingruber and Landolt, 2005-2010). All of the images in the Atlas are available in the Xylem Database, and may be used royalty-free in other publications (Fritz Schweingruber, personal communication). Newly

[1] *A complete (unillustrated) list of the character definitions can be downloaded in a Word document from the online Xylem Database Schweingruber, F. H., and W. Landolt. 2005-2010. The xylem database. Swiss Federal Institute for Forest, Snow and Landscape Research. Birmensdorf, Switzerland. http://www.wsl.ch/dendro/xylemdb/index.php.*

available from the Database (as of April 1, 2011) is a character by taxon matrix in the form of an Excel file with 3357 entries. Each entry row represents a species, while each column contains presence or absence information on each wood and bark character. The wood characteristics are listed by their extended IAWA code, while the bark features are classified according to the new character descriptions provided in the Atlas. This detailed character by taxon information is not available in the Atlas, which only provides summary tables as discussed above. The availability of the full matrix makes it possible to conduct correlation analyses that are not included in the Atlas. Dr. Schweingruber is to be commended for making this data freely available, something that few other scientists have ever done.

Having covered many of the strong points of the Atlas, I now turn to a brief consideration of some of its weaknesses. While the production quality of the Atlas is, on the whole, excellent, the resolution of some of the images has been degraded because of they are oversaturated in the magenta (Fig. 1). Comparison of the published images with those available from the Xylem Database shows that these are clearly production errors, and are not due to the original quality of the images. One expects better from Springer.

A second unusual feature of Springer's production relates to their release of the Atlas through the SpringerLink website.[2] Although Springer offers this book through SpringerLink to subscribing institutions, only the title pages, table of contents, list of abbreviations, and the index, are available online. The whole text of the book is missing from the online version. One wonders at the thought process behind the decision to place the book online, but exclude all of its contents.

While I am very happy with the visual treatment of character definitions in the Atlas, I still feel that more can be done to clarify characters through visual means (Kirchoff et al., 2007; Leggett and Kirchoff, 2011). For instance, the distinction between ring porous (character 3) and semi-ring porous (character 4) secondary growth has always been a matter of degree. How much difference in vessel size must exist between the early and late wood for a species to be classified as ring porous? Neither the IAWA character definitions nor the Atlas deal with this problem. One approach to this seemingly intractable problem is to define the character states based solely on visual criteria. This can be done by creating groups of images that represent the two main categories, ring porous and semi-ring porous. Intermediate states between these two main categories can also be represented by groups of images. In this approach the groups of images themselves become the character definitions. Terms are used only as secondary labels for the groups of images. This procedure is illustrated for the inudentum of oak leaves in Fig. 2. The black (and grey) boxes in this figure represent the character states for this character. These character states are not described verbally, but labeled with letters (A – E) so that they may be easily referenced. The image groups themselves define the character states. In one case, character state E, there are subsidiary states (groups) within the main character state. This subdivision of character state E illustrates the fine type of distinctions that can be made with visual definitions. Using a visual approach it is possible to define characters and character states in very precise ways, yet at the same time show the variation within each state. As visual character definitions are used in practice, new images can be added to the character state groups so that a record is kept of the variation within each character state. In this way it is possible to continually reevaluate the viability of each state as new data (images) are added. It is also possible for new investigators to quickly evaluate the quality of the characters and character states that have been used in previous studies. I hope that method such as this will come into wider use in the near future.

In summary, the Atlas of Stem Anatomy in Herbs, Shrubs and Trees is an important new contribution to our knowledge of stem anatomy, and particularly to our knowledge of the occurrence of secondary growth in so-called herbaceous plants. In addition to completely changing our concept of what it means to be herbaceous, the Atlas provides important information on the structure of the bark in many species that have not been previously studied. Coupled with the information available through the online Xylem Database, the Atlas has to be viewed as one of the most important publications in plant anatomy and morphology of recent years.

[2] *http://www.springerlink.com/content/978-3-642-11637-7*

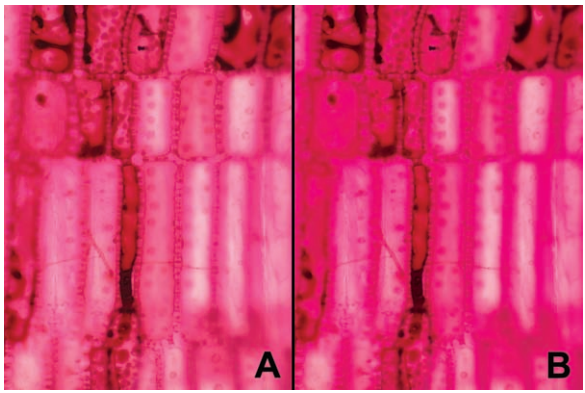
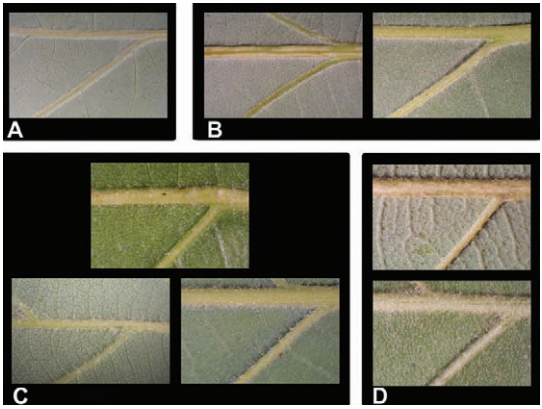
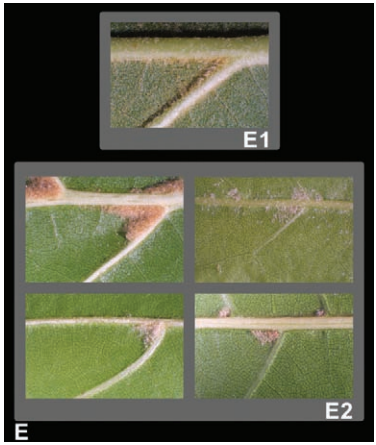


Figure 1: Simulation comparing a normal image (A) with one with oversaturated magenta (B). The fine details (pits, etc.) are obscured in the oversaturated image. The images are from Fig. 6 (Ambroella trichopoda) from the chapter of the Atlas on the Ambrollaceae (Schweingruber et al., 2011). The photograph is of a radial section showing upright ray cells with bordered pits in uniseriate axial rows. To produce the figure the raw image was downloaded from the Xylem Database (Schweingruber and Landolt, 2005-2010), duplicated and brought into Photoshop CS. The RGB image was converted to CMYK, after which a Hue/Saturation adjustment layer was used to adjust the magenta +8 points so that the digital images were as close as possible to the published image in hue. The channel mixer was then used with a clipping mask on the right image (B), and magenta was increased to +114% on the magenta channel. The resulting right image (B) matched the detail that is visible in the printed original.

Figure 2: Visual character description – inudentum on abaxial surface of oak leaves. Character states are defined by the images in each box, not verbally. Inclusion of multiple images is used to show variability in the state. In this example each character state is denoted by a letter (A-E), and one (E) has two sub-states (E1, E2). Species identification follow. A, Quecus alba. B, Q. muehlenbergii (left), Q. macrocarpa (right). C, Q. bi-color (above), Q. prinus (below left), Q. michauxii (below right). D. Q. stellata (above), Q. falcata (below). E1, Q. velutina. E2, Q. schumardii (above left), Q. phellos (above right), Q. palustris (below left), Q. nigra (below right).





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Ecological

Carnivorous Plants and their Habitats Volumes One and Two.

McPherson, Stewart. 2011. (£34.99 each) 1441 pages, 799 images total. www.redfernnaturalhistory.com

Stewart McPherson, the author of Carnivorous Plants and their Habitats Volumes One and Two, frightens me. This is a good thing, as I work on carnivorous plants, and Stewart's incredible output to date, 8 volumes of 500-plus pages each, is a wonderful motivator. Thank God he's not a physiologist or I soon might not have anything to work on. His work is even more remarkable when one considers the quality (reams of gorgeous and informative photos, eminently readable text, detailed history, current phylogenetic approach, etc.).

These two volumes cover carnivorous plants, first conclusively confirmed to be such by Darwin, in total and in detail. McPherson begins with overall discussions of the history of our understanding of these plants and a general overview of currently accepted groups. He then considers their evolution, associated organisms other than prey, and habitats in a general sense. The various groups of carnivorous plants are considered by the type of trap (e.g. pitcher plants) rather than taxonomically, and, finally, their future, troubled as it is by habitat degradation and loss. The Appendix, Bibliography, and Index round out this two-volume set. The grouping by trap type makes great sense given the similar habitats of plants with similar traps and the way that enthusiasts of carnivorous plants usually think about these green monsters.

This is a very complete work, in many ways the most complete work on carnivorous plants done by anyone, anywhere. McPherson even works in the newly identified carnivorous and barely known genus Philcoxia (there have been no more than a tiny handful of papers on it) with lovely habitat shots and closeups. He includes UV reflection images of various traps to indicate the view that insects receive. He includes many, many genera (briefly) of sub-/proto-/hemicarnivorous plants. The taxonomic discussion is deep and