

Book Review

***An Introduction to Plant Structure and Development.*
Plant Anatomy for the Twenty-First Century (Second Edition). 2007
by Charles B. Beck. Cambridge University Press.
New York, NY, USA. 441 pp. ISBN 978-0-521-51805-5 (Hardback)**

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In the spring of 1987, I was pursuing a dissertation on a genus of phytophagous insects. Therefore, I decided to garner a greater understanding of insect-plant interactions by taking botany courses. That is how my love for plants, whose seed had been planted by my paternal grandmother, Pina, and by a legendary botany professor in Puerto Rico, Roy Woodbury (Santiago-Blay et al. 2004), germinated and has grown ever since. For years, I have seen the biological world with a different understanding of and appreciation for it. Three decades after I took a professional and personal life-changing course, *Principles of Plant Morphology* (Botany 105) with one of the masters of the craft, Dr. Donald R. Kaplan (Department of Botany, University of California, Berkeley), I had the opportunity to teach a research course in plant morphology elsewhere.

Plant morphology, whether external or internal, the latter also known as plant anatomy, as well as plant development are taught using different pedagogical approaches and with different conceptual emphases. Beck's *An Introduction to Plant Structure and Development* represents an example of what I like to refer to as a "traditional" conceptual emphasis. A course taught this way begins with cells (or lower rungs of the biological hierarchy) and it tends to stay at the levels of tissues and organs. Esau (1977) as well as her other well-known and valuable botanical anatomy books are examples of this approach as are Stevens (1911), Jeffrey (1922), Eames (1936), Maheshwari (1951), and Fahn (1974), to give a few examples. Depending on the book, different areas of botany are emphasized, including anatomy, physiology, development, different plant groups, or microscopy techniques. This approach tends to diminish its emphasis on the equally valuable and complementary whole-organism approach.

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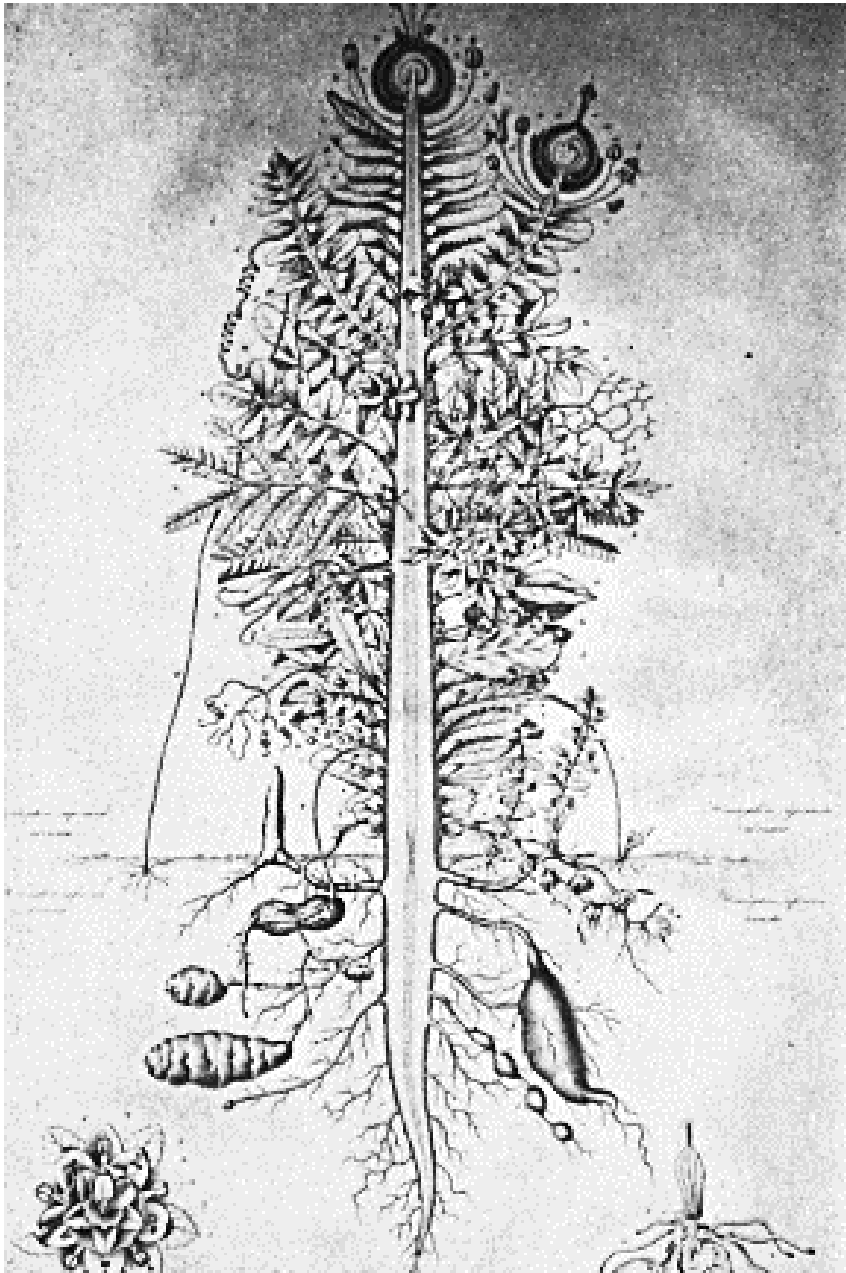


Figure 1. Homologies in plants as depicted by Arno Bliedner (1901) in *Goethe und die Urpflanze*. <https://babel.hathitrust.org/cgi/pt?id=mdp.39015030181161&view=1up&seq=90>

Foster and Gifford (1974), *Comparative Morphology of Vascular Plants*, represents an intermediate approach to the subject matter, showing greater emphasis in homologies (Figure 1) and dwelling more into plant evolution and the fossil record. At the time I took *Principles of Plant Morphology*, Dr. Kaplan's phenomenal lectures and laboratory exercises were supplemented by our readings of this textbook.

As a scholarly pursuit, plant morphology began in 1790 with the publication of *Versuch die Metamorphose der Pflanzen zu erklären* (Kaplan 2001) or, in English, *Attempt to Explain the Metamorphosis of the Plants* written by the German scholar and statesman, Johann Wolfgang von Goethe (1749-1832), known to many of us as the author of *Faust*. Goethe, and others in the organographic tradition, emphasized homologies, or structures that share a most recent common ancestor. According to Teichmann (2005),

'... Goethe sets out for Italy. On this journey, his whole structure of thoughts and ideas is soon brought into fluid motion.! In Padua on September 27, 1786, he [Goethe; square brackets, its contents, and underscores are mine] notes: Amidst this new array of different sorts of plants, the idea emerges ever more strongly that perhaps all forms of plants could be developed out of one.' ...

"This is where I [Goethe] have been stuck in my botanical studies and I do not yet see my way out of the confusion."

'Just a few months later, in Rome (February 19, 1787), he [Goethe] seems more hopeful:

"I [Goethe] am on my way to discovering new and wonderful indications how Nature, what an incomparable monster, lets the manifold evolve out of the simple."

'Then, not long after this, in the botanical garden in Palermo, Goethe finally grasps the idea of the archetypal plant. This idea, which permeates all his future work, is not merely a discovery that allows him to bring order to a small segment of his surroundings.'

However, like many other organisms, plants have the proclivity of functioning (e.g., spreading in space and time), by using, or co-opting, different structures, such as shoots, roots, propagules that are not necessarily homologous.

Structures that perform similar functions and are not considered to be homologous, are said to be analogous. The book, *Plant Form. An Illustrated Guide to Flowering Plant Morphology* by Bell (2008) seem to follow this tradition, emphasizing how the whole plant uses both homologous and analogous structures to adapt and thrive. This approach, which is more organismic, also highlights how plants regulate their form through their internal interactions at the cellular level and below. In other words, just like animals, plants are not just like bricks in a wall, but functionally integrated entities.

An Introduction to Plant Structure and Development, the second edition subtitled *Plant Anatomy for the Twenty-First Century*, does an excellent job of explaining and gloriously illustrating many principles as well as morphological and anatomical details of the vascular plant body. Like the first edition, the book includes overviews of the plant body (Chapters 1-2), and discussions of cells and cell walls (Chapter 3-4), the ubiquitous meristems (Chapter 5), primary growth of the vascular system (Chapter 6), branching (Chapter 7), epidermis (Chapter 8), secondary growth (Chapter 9), vascular cambium (another meristematic tissue, Chapter 10), secondary xylem (Chapter 11), phloem (Chapter 12), periderm and related peripheral structures (Chapter 13), unusual structures of the shoot and root (Chapter 14), secretions (Chapter 15), root (chapter 16), leaves (chapter 17), and reproduction (chapter 18).

I found the following features particularly interesting. First, the detailed description of the many meristematic tissues in the plant body, not only the apical meristems or the vascular cambium. Second, the discussion of the anatomy of wood. Third, the gaudily illustrated chapter on plant secretions, an area of plant sciences several colleagues and I have explored for decades (e.g., Santiago-Blay and Lambert 2017).

Beck's treatment of plant morphology made me look back on what I had learned through the decades after taking Kaplan's course and enrich it through the extensive preparation I completed for my course. Also, this teaching opportunity forced me to think about doable projects students could pursue, particularly following the morphological and anatomical patterns in detail as they development in a variety of non-model plants at the anatomical level.

Future books in plant morphology, including anatomy, and development could be enriched by having, first, more detailed treatments of the molecular genetic mechanisms underlying many of the anatomical, morphological, and developmental processes (e.g., the origin and development of leaves and flowers) described. Second, including the non-vascular plants, or "bryophytes", as an integral part of this botany book would give a fuller picture of the botanical world. Third, placing as much morphology and development as possible in an ecological and evolutionary context, including the fossil record. Fourth, pedagogically, having its content presented in such a way as to help readers place the search for

answers in the context of the scientific method. This pedagogical approach includes stating the questions being asked (and discussing what motivated them), if applicable, designing testable hypotheses, explaining why the methods used to find answers are appropriate, and making connections between the answers found and the key principles that encompass the remaining pertinent body of knowledge in the field. Fifth, placing greater emphasis on the taxonomic group of plants being discussed with an indication of where plants being discussed fit in the fossil record makes learning more long-lasting and enjoyable. Sixth, including a lavishly illustrated laboratory companion (e.g., Bowes and Mauseth 2008, Ruthorth et al. 2016) makes learning stick by having meaningful reinforcing and authentic discovery hands-on activities.

As there are “no current plans for a third edition of this book” (unidentified editor at Cambridge University Press to L. Ohprecio to Santiago-Blay, personal communication, December 3, 2019), perhaps a well-integrated multidisciplinary team of practitioners of the discipline who, as Kaplan, are also excellent teachers, could pursue the suggested project.

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Erratum

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On a recent book review (Santiago-Blay 2019 *Life: The Excitement of Biology* 7(1):36-40), I misspelled the title of the book, *The Spark of Learning*. Embarrassingly, I wrote *The Spark of Leaning* (note the absence of the “r”). I apologize to the author, Dr. Sarah Rose Cavanaugh, and to the readers. Wholehearted thanks to the reader who reported my error.