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Response by Kevin Boyce

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# PRESENTATION OF THE 2011 CHARLES SCHUCHERT AWARD OF THE PALEONTOLOGICAL SOCIETY TO C. KEVIN BOYCE

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FELLOW PALEONTOLOGISTS, I first came to know Kevin Boyce around the turn of the century, when, as a graduate student at Harvard, he was working out a novel scheme to characterize leaf morphology. It was clear from the get-go that this was someone to watch. Kevin's mentor Andy Knoll has sent many first-rate paleontologists into the world, but this was one of those cases where the advisor just needs to stand out of the way and let the student go full-tilt. Already as a student, Kevin had the vision and drive to work independently. And, like many a young scholar seeking to avoid distractions at the office, he wrote his Ph.D. thesis sitting at home. But he used an additional 'trick': he always wore a *necktie* while writing, to keep himself disciplined.

Prior to doing his Ph.D. at Harvard, Kevin earned *not one but two* bachelor's degrees from CalTech (where, among other things, he worked with Joe Kirschvink on the sensitivity of honeybees to magnetic fields). His dual degrees might not stand out in these days of hypercompetitive undergrads pursuing triple and quadruple majors, but I've always been struck by the fact that he has a Bachelor of *Science … in Literature*. Now, if you ask Kevin about this, he'll respond that CalTech only gives B.S. degrees regardless of the field, but I know from talking with him about a whole range of topics that he approaches everything with the same imagination and insight that he brings to paleontology. For example, he has thoroughly studied the King James Bible and has developed a reinterpretation of the Old Testament … as a *comedy*. His interest in literature goes far beyond reading—he writes poetry that has been described as beautiful. In fact, he wanted to become a writer, but his mother suggested he have a back-up plan to make a living, so he became a paleontologist. (How many mothers would consider *paleontology* a safe career track?!) Actually, Kevin's love of paleontology does go back to childhood. He grew up in L.A., virtually across the street from La Brea, and used to hang out at the tar pits as a boy. And he had a copy of Yale's classic *Age of Reptiles* mural by Rudolph Zallinger hung over his bed. Lying in bed, staring at the mural is what initially got him hooked. And when he returned to paleontology after college, one of the first things he did was get another copy of that poster so that he could see how the depiction held up as he learned more about the plants and animals and their environments. (And to this day, whenever Kevin sees a copy of that mural in a public place, he points out to anyone who will listen how our understanding of the plants, dinosaurs, and landscapes has evolved since Zallinger's time.)

So, back to the point, as I got to know this promising young scientist, I became mildly annoyed that we had failed to lure him to Chicago for his Ph.D. But, a few years later, following the general principle that you can run but you can't hide, I invited him to give a seminar in my department. His elegant opening words (easily remembered even after ten years) explained *three reasons* why plants are ideal for studying evolution and development in the fossil record: *First* … they have cell walls (allowing complete anatomical preservation). *Second* … they have cell walls (so the cells don't move, allowing ontogeny to be directly inferred from adults). *Third* … (you guessed it) … they have cell walls (which preserve organics, thus allowing detailed biochemical analysis).

How could anyone argue with that? We hired him onto the faculty right away and have been delighted ever since.

Like other great naturalists, Kevin does not have a merely academic interest in his study organisms—he has a real passion and affection for them, even an obsession. His house plants are covered with dots painted on the leaves as they grow, so he can follow their development; guests at his home are so used to this by now that they no longer ask about the dots. He also likes to go on walks but has been known to take two hours to cover one block, since he stops to dissect every plant along the way. And like many a devoted husband, he often brings flowers to his wife. Unlike most, however, he immediately proceeds to perform a thorough dissection, leaving her with an array of carefully laid out petals, anthers, and carpels, rather than a bouquet.

Outside the home, Kevin is widely recognized as an international leader in the interpretation of ancient plant structure, ecology, and macroevolution. His high stature among the young cohort of paleontologists is evident, for example, in his having been chosen to speak at the Paleo Society's Centennial Short Course in 2008. And he has equal standing within botany, as one can see from invited reviews he has written on the history of roots and leaves and on the evolution of plant development.

Although he has a rich understanding of fossil forms, Kevin's starting point is the modern representatives whose biology is much more thoroughly understood. Let me mention just a few of his contributions to give a sense of the breadth of questions he addresses:

- With Andy Knoll, he showed that plants evolved leaves several times independently, each time by modifying a common ancestral developmental pathway in a broadly similar way. At the same time, differences in these initial modifications were retained by the descendant lineages and guided subsequent evolutionary changes. This work elegantly illustrates the importance of developmental biology for understanding macroevolution, and demonstrates both the enabling and the limiting roles of developmental constraints.
- By measuring hydraulic properties of leaves, and the density and pattern of their veins, Kevin, along with Maciej Zwieniecki and Missy Holbrook, has demonstrated that the tendency for leaves to be smaller near the top of the forest canopy and larger down below—so-called ''sun'' versus ''shade'' leaves—is a function of how much water can be pumped to different levels. The leaves are the same size when the buds first break, but those near the bottom subsequently get more water and expand more. (Together, these three also produced a very interesting theoretical design space based on functional hydraulic

characters). For ancient leaf assemblages, as Kevin has argued, it should be possible to interpret the frequency distribution of leaf sizes in terms of the density of ancient forests. This will be important in reconstructing past ecosystems, and it also has the potential to provide essential constraints to climate modelers who need to know about the nature of vegetation in the past.

- Kevin has cleverly reinterpreted a number of ancient, enigmatic organisms. For example, he demonstrated that many Silurian and Devonian *Cooksonia*-like plants were too small to house ample photosynthetic tissue and therefore must have been physiologically dependent upon a gametophyte, rather than being independent, photosynthetic individuals. He also provided the crucial, carbon-isotopic evidence in support of Fran Hueber's idea that the 8-meter-plus, tree-like Devonian *Prototaxites* was a giant fungus.

The style of these works is to take what we know about the chemistry and biology of living forms and use that to make sense of the ancient forms in novel, imaginative, and rigorous ways. What I find so appealing about these works is that Kevin does not stop at having a better model of the ancient organism. He applies this new knowledge to improve our understanding of ancient landscapes and the evolution of terrestrial ecosystems, which has important implications for carbon cycling, climate, and geomorphology. In other words, he takes what starts out as a paleobotanical study and applies it to big problems in Earth science. Some of these studies may seem forehead-slappingly obvious in hindsight, so naturally I was tempted to use a corny botanical metaphor and say that Kevin is adept at picking *low-hanging fruit*. … But then it occurred to me that most of the plants Kevin works on didn't even *have* fruit.

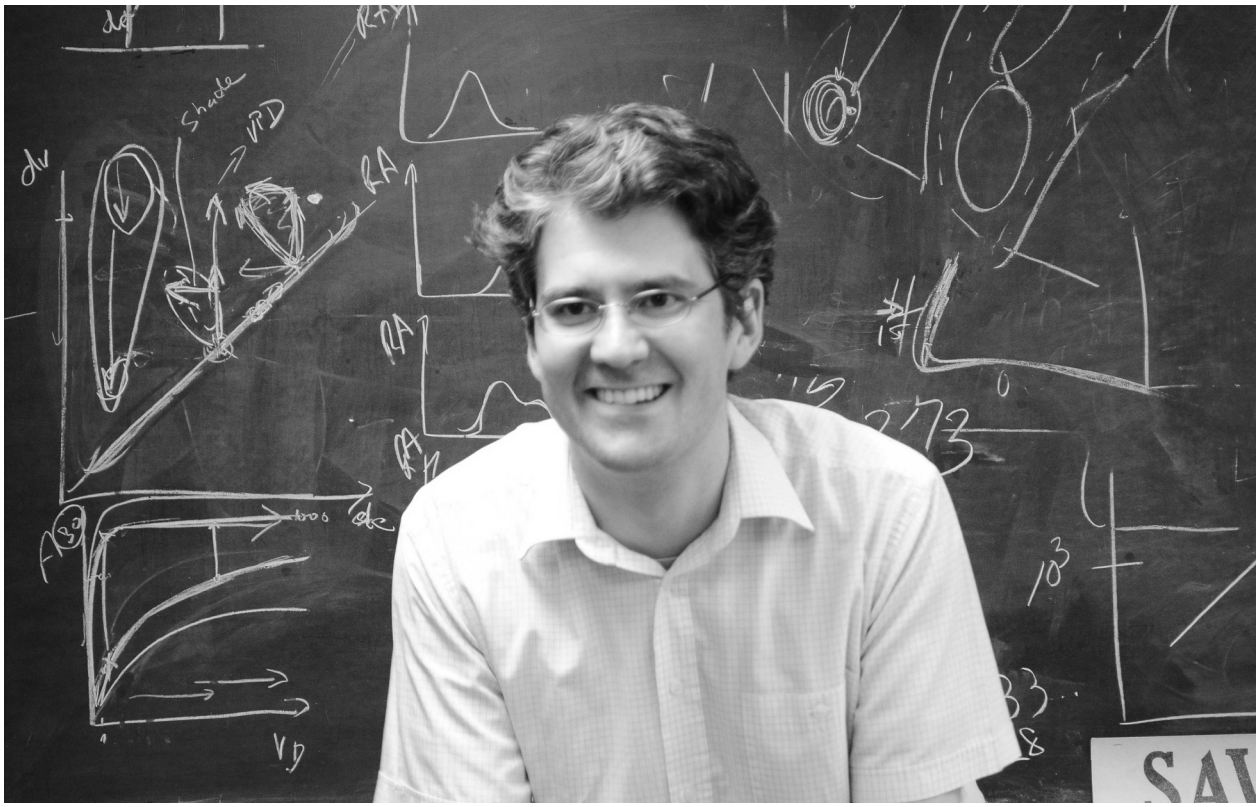
- But some of them do, which brings us to his recent work on angiosperm venation. Working with Tim Brodribb, Taylor Field, and Maciej Zwieniecki, Kevin has documented that angiosperm leaves, being more densely veined, can transpire more water than those of all other major plant lineages. This implies that only forests consisting of angiosperms are capable of recycling enough water locally to produce anything analogous to today's tropical rainforests. Thus, a major biome did not exist for most of the history of land plants. Also, the advent of rainforests may have had profound implications for global climate. Kevin has followed through on this work by collaborating with climate modeler Jung-Eun Lee to compare the spatial distribution of temperature and rainfall in present-day rainforests with what would be expected in a non-angiosperm world (or a severely deforested world).

As I hope these examples show, Kevin Boyce is at the leading edge not only of paleobotany but of paleontology more broadly. His contributions are widely appreciated as advances that bear his unique stamp. He has helped our profession put a good foot forward by pursuing a research program that has implications not only for paleontology but also for geology, botany, and Earth systems science, and by publishing his work in diverse and prominent venues, including *Proceedings of the National Academy of Science*s, *Proceedings of the Royal Society*, *Geology*, *Journal of Geophysical Research*, *International Journal of Coal Geology*, *American Journal of Botany*, *International Journal of Plant Science*, and, of course, *Paleobiology*. Kevin has also served the Society and the profession at large in a number of roles, including as an early member of the Paleobotany Working Group of the Paleobiology Database, Chair of the Paleobotanical Section of the Botanical Society, and Associate Editor for *Paleobiology*.

Before closing, I'd like to give personal thanks to Kevin for being such a treasured colleague over the years. Whether it's in a seminar, a student committee meeting, or a dreaded faculty meeting, Kevin's is the voice of reason. He's a great citizen, generous with his time, and patient with those (like yours truly) who do not catch on as quickly as he does. It's a truism that the test of whether you understand something is whether you can teach it to the masses of undergraduates who have no prior knowledge of the subject—let alone any interest in it. When I first taught a non-majors course on *Environmental History of the Earth*, Kevin held my hand as I tried to come to grips with things I previously *thought* I understood—GEOCARB, Snowball Earth, the Canfield Ocean, etc. When Arnie Miller and I were writing a textbook a few years back, I remember thinking that any passage, table or figure that concerned plants had better pass muster with Kevin or it simply wouldn't do. As I put extra effort into the plant sections, I fell into the classic trap: being too thorough about something you don't fully understand, since you can't really see what's essential and what's secondary. Kevin pulled me out of this trap, showing where I had included way too much detail for an undergraduate text. (And, if the poor sales of that book are any indication, I should have left even more on the cutting room floor. Sorry, Arnie.)

Members of the Paleontological Society and distinguished guests, it is a great pleasure—and an honor—to present to you the recipient of the 2011 Charles Schuchert Award, C. Kevin Boyce.

# RESPONSE BY KEVIN BOYCE




THANK YOU, Michael. And thank you very much to the society. I am both honored and fairly uncomfortable being added to a list of Schuchert awardees that includes so many personal heroes. I am particularly aware of how long it's been since the last paleobotanist was up here and I'd like to ask a question that the three previous botanical awardees each asked in their own ways, gently and more diplomatically—what's so wrong with plant fossils? Plants fall apart, I get that, but so does even a snail if you consider that the entire living organism rots away. And plants have so much to offer a paleontologist: cell walls and organic cellular preservation, and development and physiology directly interpretable from that preserved anatomy. Even if fragmented, the whole organism is there. I was not born with any love of plants and never thought twice about them before grad school, but once I had the epiphany that plants have cell walls and cell walls make all the difference, it could only have been willful, contrarian self–destructiveness to resist working with them. Seriously, how can it be that all of you are not paleobotanists?

As confused as I remain regarding your career choices, I have been inspired by the stellar, insightful work that has been done with the paleobotanical record. Karl Niklas, Bill DiMichele, Scott Wing, Bill Stein, Michael Cichan, Gar Rothwell, Pat Gensel, Peter Wilf—these are all people that could have been up here for this honor before. And our current younger generation makes me hopeful that it won't be another 20 years before it happens again.

My start as a paleontologist was perhaps a bit unusual in that I was not born that way. As an undergraduate, Caltech was very efficient at teaching me that I could not be a mathematician or physicist and that I did not want to be a molecular biologist, but it left me on my own after that. It was working with Joe Kirschvink that reminded me that the doing of science can and should be fun. And at a school with no hint of paleontology, it was Chaucer and the classes of my literature major advisor, George Pigman, that first introduced me to the pleasures of working with the historical record of worlds that felt familiar on the surface, but were completely foreign on a closer look. And at that point, the remaining step to actual fossils was a small one.

In graduate school, Steve Gould, Charles Marshall, Paul Hoffman, and John Grotzinger were all valued teachers. I am particularly indebted to my advisor, Andy Knoll, for representing an ideal of scientific inclusiveness where the answer to a question in paleontology could come from sedimentology, physiology, or geochemistry. That scientific omnivory is perhaps most common in the Precambrian and I often feel like a Precambrian paleontologist homesteading in the Phanerozoic. Andy always says that you learn more from your fellow students than any advisor and he gave that idea every chance of success with Susannah Porter, Shuhai Xiao, Linda Kah, Julie Bartley, Emmanuelle Javaux, Sofya Low, Jon Payne, and the many other visitors and postdocs in his lab with whom I had the chance to interact. Frequent visitors Richard Bambach and Dolf Seilacher were particularly appreciated as examples of a scientific approach where fossils are treated not just as data, but as equal participants in an ongoing conversation.

In Chicago now, I am continually amazed by the quantity and quality of a paleontological community that has included Mark Webster, Jenny McElwain, Peter Crane, Albert Colman, Peter Makovicky, Michael LaBarbera, and Michael Coates among many others. I've been particularly grateful for the irresistible force that is Sue Kidwell and David Jablonski's enthusiasm; when in the same room with them, you cannot help but feel inspired. And Michael Foote has been a great colleague. I think I admire most his earnest, open–minded dedication to paleontology exemplified by his willingness to engage in the long email discussion through which I met him as an unknown graduate student—it began being about the cosmic significance of large negative eigenvalues in principal coordinate analyses and it ended much *much* later with my recognition that I had missed a step in the analysis by not multiplying by negative one. And he was still open to having a second conversation after that. I also have really appreciated all of the Chicago students, particularly those senior grad students already there when I arrived with whom I didn't feel like faculty, but a well protected little brother.

Along the way, Missy Holbrook and particularly my close colleague, Maciej Zwieniecki, have taught me far more physiology than I have retained and completely changed my research horizons as a postdoc. Marilyn Fogel, George Cody, and Bob Hazen provided a fantastic introduction to geochemistry at the Carnegie Geophysical Laboratory, and I am particularly grateful for Bob's initial and continued encouragement. Carol Hotton, Jung–Eun Lee, Andrew Leslie, Sue Wirick, Chris Jacobsen have all been valued collaborators. That list includes not only paleontologists, but geochemists, mineralogists, climate modelers, X–ray physicists, and physiologists. I am not properly any of those things myself, and frequent and diverse collaborations have been essential to my research. As paleontologists, it is easy to forget, but you should never underestimate the enthusiasm you can generate by walking into a stranger's office and pulling a fossil out of your pocket.

Finally, I have to thank my family: David and Christine and brother Brian, Carmita and Jesus and sister Astrid, and my three little ones Elliot, Tabitha, and Wilder.

Thank you again. And to close, I think the first botanical Schuchert, Jim Doyle, said it best: "I am deeply grateful for this token that my chosen field is not considered at the fringes of paleontology, and that my behavior in it has been acceptable."

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