

Charles Kevin Boyce

Professor & Chair
 Department of Geological Sciences
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Education

Harvard University	Ph.D., Paleontology	2001
California Institute of Technology	B.S. (with honors), Biology	1995
California Institute of Technology	B.S. (with honors), Literature	1995

Professional Experience

Professor of Geological Sciences	Stanford University	2018-
Professor, by courtesy, of Biology	Stanford University	2019-
Associate Professor	Stanford University	2013-2018
Associate Professor	University of Chicago	2010-2013
Assistant Professor	University of Chicago	2003-2010
National Research Council Associate	NASA Astrobiology Institute	2001-2003

Professional Activity

Editor, Paleobiology	2018-
Associate editor, Paleobiology	2011-2018
Member, Fellows Committee, Paleontological Society (Chair, 2018, 2019)	2017-2019
Member, W. S. Cooper Award Committee, Ecological Society of America	2014-2016
Member, Strimple Award Committee, Paleontological Society	2012-2015
Member, Beamline Advisory Team, X-ray scanning microscope, NSLS II	2008-2010
Chair, Paleobotanical Section, Botanical Society of America	2006-2007
Member, Moseley Award committee, Botanical Society of America	2004-2006
Research Associate, Geology, Field Museum of Natural History	2004-2024
Member, Cookson Award committee, Botanical Society of America	2003
Predocctoral Fellow, Carnegie Geophysical Laboratory	1999-2001

Professional Recognition

Klepser Distinguished Lectureship, University of Tennessee	2015
MacArthur Fellow, MacArthur Foundation	2013-2018
W. S. Cooper Award of the Ecological Society of America	2012
Charles Schuchert Award for excellence and promise in paleontology	2011
Fellow, Paleontological Society	2011-
Carnegie Geophysical Laboratory Postdoctoral Fellowship (declined)	2001
NSF Predocctoral Fellowship	1996-1999

Professional Outreach

Scientific advisor, Hopscotch Girls "Science! STEM Sticker Adventure" book	2018
Scientific advisor, Dinosaur Garden, Palo Alto Junior Museum and Zoo	2017-
Extended advisor, Paleobiology Hall exhibit renovation, Smithsonian NMNH	2014-2015

Professional Service

Reviewer for: American Journal of Botany; American Journal of Science; American Mineralogist; American Naturalist; Annals of Botany; Applications in Plant Sciences; BMC Evolutionary Biology Reviews; Chemical Geology; Current Biology; Earth & Planetary Science Letters; Ecological Monographs; Geobiology; Geochimica et Cosmochimica Acta; Geological Journal; Geological Society of America Bulletin; Geology; International Journal of Plant Science; Journal of Biogeography; Journal of Geology; Journal of the International Association of Wood Anatomists; Journal of Magnetic Resonance; Journal of Paleontology; Journal of Theoretical Biology; Nature Communications; Nature Ecology & Evolution; Naturwissenschaften; New Phytologist; Organic Geochemistry; Palaeogeography, Palaeoclimatology, Palaeoecology; Palaeontology; Palaios; Paleobiology; Paleontological Research; Plant, Cell & Environment; Plant Physiology; Planta; Proceedings of the National Academy of Sciences; Review of Palaeobotany & Palynology; Science. Advanced Light Source, LBNL; American Chemical Society; NASA Exobiology; NSF Earth Sciences; NSF Geobiology and Low-Temperature Geochemistry.

Professional Affiliations

Botanical Society of America, Geological Society of America, International Organization of Palaeobotany, Paleontological Society.

University Service

Stanford University

Chair, Geological Sciences	2020-
Director of Graduate Studies, Geological Sciences	2019-2020
Acting Chair, Geological Sciences	2019
Associate Chair, Geological Sciences	2017-2019
Junior Faculty Mentor, School of Earth, Energy & Environmental Sciences	2019-
Faculty Search Committee (Chair), Geological Sciences	2017-2018
Committee on Graduate Studies, Stanford University	2016-2018
Undergraduate Curriculum Committee, Geological Sciences	2015-2017
Departmental seminar organizer, Geological Sciences	2014-2016
Graduate Admissions Committee, Geological Sciences	2013-2015
Geobiology Faculty Search Committee, School of Earth Sciences	2013-2014

University of Chicago

Faculty Appointments Committee, Geophysical Sciences	2012-2013
Hinds Fund Fellowship Committee, Committee on Evolutionary Biology	2011-2012
Departmental Chair Search Committee (Chair), Geophysical Sciences	2011-2012
Faculty Appointments Committee, Committee on Evolutionary Biology	2011-2013
Fluids Faculty Search Committee, Geophysical Sciences	2011-2012
Chamberlin Postdoctoral Fellow Search Committee, Chair	2009-2010
Departmental Chair Search Committee, Geophysical Sciences	2008-2009
Graduate Admissions Committee, Committee on Evolutionary Biology	2005-2008
Noon Balloon Faculty Seminar (Czar), Geophysical Sciences	2004-2007
Evaluation Committee, Crerar Undergraduate Science Writing Prize	2004-2011

Teaching Experience

Stanford University

GS/EarthSys128/228, Bio148/228	Evolution of Terrestrial Ecosystems
GS/EarthSys 205	Fundamentals of Geobiology
GS/Bio 206	Topics in Organismal Paleobiology (Previous topics: Biological fluid flow, Vertebrate evolution, Paleobotany, Insect evolution)
GS/EarthSys 208	Topics in Geobiology

University of Chicago

GEOS 13200	Historical Geology
GEOS 32500	Evolutionary History of Terrestrial Ecosystems
GEOS 34600	Chemical Information in the Sedimentary and Fossil Records
GEOS 39711	Paleobotany

Student Supervision

Stanford University

Sandra Schachat (Ph.D. candidate; co-advised with Jonathan Payne)—Evolution of winged insects
Michael D'Antonio (Ph.D. candidate)—Structure and biology of arborescent lycopsids
Andrés Baresch (Ph.D. candidate)—Evolution of leaf physiology
Thesis committee member: Ellen Schaal, Caitlin Keating-Bitonti, Jeremy Caves, Matthew Winnick, Will Gearty, Richard Stockey, Tyler Kukla
Thesis examination chair: Simon Wong, Graham Dow, Kelli Davies, Daniel Ibarra, Hsiao-Tieh Hsu, James Russell, Taylor Martin, Max Segnitz
Undergraduate research supervision: Catriona Breasley (University of St. Andrews)
Undergraduate pre-major adviser: 8 students

University of Chicago

Marites Villarosa Garcia (Ph.D. 2017; co-advised with Michael Foote)
The morphological diversity of coccolithophores across environments, geographic space, and geologic time
Kathryn Larson (Ph.D. 2012)
The evolutionary and biogeographic consequences of fruit form evolution in Fagales
Larson-Johnson, K. submitted. Wind variability limits the potential influence of fruit morphology and descent rate on dispersal in the winged fruits of *Carpinus* (Betulaceae).
Larson-Johnson, K. 2016. Field observations of *Carpinus* (Betulaceae) demonstrate high dispersal asymmetry and inform migration simulations with implications for times of rapid climate change. *International Journal of Plant Sciences* 177: 389-399.
Larson-Johnson, K. 2016. Phylogenetic investigation of the complex evolutionary history of dispersal mode and diversification rates across living and fossil Fagales. *New Phytologist* 209: 418-435.
Hilary Christensen (Ph.D. 2012)
Mammalian adaptation to herbivory in the aftermath of the K/T extinction
Christensen, H. B. 2014. Similar associations of tooth microwear and morphology indicate similar diet across marsupial and placental mammals. *PLoS ONE* 9: e102789.
Andrew Leslie (Ph.D. 2010)

Forms follow functions: Exploring the evolution of morphological diversity in seed plant reproductive structures

- Leslie, A. B. 2011. Predation and protection in the macroevolutionary history of conifer cones. *Proceedings of the Royal Society of London B* 278: 3003-3008.
- Leslie, A. B. 2011. Shifting functional roles and the evolution of conifer pollen-producing and seed-producing cones. *Paleobiology* 37: 587-602.
- Leslie, A. B. 2010. Flotation preferentially selects saccate pollen during conifer pollination. *New Phytologist* 188: 273-279.
- Leslie, A. B. 2008. Interpreting the function of saccate pollen in ancient conifers and other seed plants. *International journal of plant sciences* 169: 1038-1045.
- Mark Gorman (M.S. 2013) Earliest record of insect herbivory found on Carboniferous leaves
- Andrés Baresch (M.S. 2013) Simulating water use efficiency along an altitudinal gradient
- Thesis committee member: Michael Glotter, Sam Miller, Matt Nelsen, Marie Hoerner, Lauren Sallan, David Bapst, Tyler Mason, Christina Belanger, Josh Miller, Leila Zajac, Rebecca Terry, David Sunderlin, Carl Simpson, Andy Simpson
- Undergraduate senior theses: Benjamin Casterline, Persephone Ma
- Five high school honors theses

Postdoctoral Supervision

- Kathryn Larson (2014-2016) Evolution of wind dispersed fruits
- Matthew Nelsen (2014-2016) Evolution of fungal metabolisms
- Jung-Eun Lee (2009-2010) Feedbacks between plant evolution and climate

Research Publications (*-indicates student or postdoctoral advisee)

61. Ielpi, A., M. G. A. Lapôtre, M. R. Gibling, **C. K. Boyce**. Submitted. Rivers meandering towards the forest.
60. D'Antonio, M. P.*, **C. K. Boyce**, W. Zhou, H. W. Pfefferkorn, J. Wang. Submitted. Primary tissues dominated ground-level trunk diameter in *Sigillaria*: evidence from the Wuda Tuff, Inner Mongolia.
59. Schachat, S. R.*, J. L. Payne, **C. K. Boyce**, D. Lentink. Submitted. Lepidoptera demonstrate the relevance of Murray's Law to circulatory systems with tidal flow.
58. **Boyce, C. K.**, D. E. Ibarra, M. P. Nelsen, M. P. D'Antonio*. Submitted. Paleozoic coal shaped the evolution of Mesozoic ecosystems and nitrogen-based symbioses.
57. D'Antonio, M. P.*, **C. K. Boyce**. Submitted. Secondary phloem in arborescent lycopsids.
56. Thérout-Rancourt, G., A. B. Roddy, J. M. Earles, **C. K. Boyce**, M. A. Zwieniecki, M. E. Gilbert, D. Tholen, A. J. McElrone, K. A. Simonin, C. R. Brodersen. 2021. Maximum CO₂ diffusion inside leaves is limited by the scaling of cell size and genome size. *Proceedings of the Royal Society of London B* 288: 20203145
55. Zhou, W., D'Antonio, M. P.*, **C. K. Boyce**, J. Wang. In press. An upright psaroniaceous stump and two surrounding pectopteroids from the early Permian Wuda Tuff Flora. *PalaeoWorld*.
54. Zhou, W., J. Pšenička, J. Bek, M. Wan, **C. K. Boyce**, J. Wang. In press. A new anachoropterid fern from the Asselian (Cisuralian) Wuda Tuff Flora. *Review of Palaeobotany & Palynology*.
53. D'Antonio, M. P.*, **C. K. Boyce**, J. Wang. In press. Two new species of *Sigillaria* Brongniart from the Wuda Tuff (Asselian: Inner Mongolia, China) and their implications for lepidodendrid life history reconstruction. *Review of Palaeobotany & Palynology*.

52. D'Antonio, M. P.*, **C. K. Boyce**. 2020. Arborescent lycopsid periderm production was limited. *New Phytologist* 228: 741-751.
51. Nelsen, M. P., R. Lücking, **C. K. Boyce**, H. T. Lumbsch, R. H. Ree. 2020. The macroevolutionary dynamics of symbiotic and phenotypic diversification in lichens. *Proceedings of the National Academy of Sciences* 117: 21495-21503.
50. D'Antonio, M. P.*, Ibarra, D. E., **C. K. Boyce**. 2020. Land plant evolution decreased, rather than increased, weathering rates. *Geology* 48: 29-33.
49. Nelsen, M. P., R. Lücking, **C. K. Boyce**, H. T. Lumbsch, R. H. Ree. 2020. No support for the emergence of lichens prior to the evolution of vascular plants. *Geobiology* 18: 3-13.
48. Zhou, W., D. Li, J. Pšenička, **C. K. Boyce**, J. Wang. 2019. A left-handed fern twiner in an early Permian swamp forest. *Current biology*. 29: R1172-R1173.
47. Ibarra, D. E., J. K. Caves, A. Bachan, A. Baresch*, K. V. Lau, D. L. Thomas, J. E. Lee, **C. K. Boyce**, C. P. Chamberlain. 2019. Modeling the consequences of land plant evolution on silicate weathering. *American Journal of Science* 319: 1-43.
46. **Boyce, C. K.**, M. A. Zwieniecki. 2019. The prospects for whole-plant physiology in fossils. *New Phytologist* 223: 40-49.
45. Baresch, A.*, C. Crifò, **C. K. Boyce**. 2019. Competition for epidermal space in the evolution of leaves with high physiological rates. *New Phytologist* 221: 628-639.
44. **Boyce, C. K.**, W. A. DiMichele. 2018. Fast or slow for the arborescent lycopsids? *New Phytologist* 218: 891-893.
43. Schachat, S. R.*, C. C. Labandeira, M. R. Saltzman, B. D. Cramer, J. L. Payne, **C. K. Boyce**. 2018. Phanerozoic pO_2 and the early evolution of terrestrial animals. *Proceedings of the Royal Society of London B* 285: 20172631.
42. Thérout-Rancourt, G., J. M. Earles, M. E. Gilbert, M. A. Zwieniecki, **C. K. Boyce**, A. J. McElrone, C. R. Brodersen. 2017. The bias of a 2D view: Comparing 2D and 3D mesophyll surface area estimates using non-invasive imaging. *New Phytologist* 215: 1609-1622.
41. **Boyce, C. K.**, Y. Fan, M. A. Zwieniecki. 2017. Did trees grow up to the light, up to the wind, or down to the water? – How modern high productivity colors perception of early plant evolution. *New Phytologist* 215: 552-557.
40. **Boyce, C. K.**, J. E. Lee. 2017. Plant evolution and climate over geological timescales. *Annual Review of Earth & Planetary Sciences* 45: 61-87.
39. Zwieniecki, M. A., K. S. Haaning, **C. K. Boyce**, K. H. Jensen. 2016. Stomatal design principles in synthetic and real leaves. *Journal of the Royal Society Interface* 13: 20160535.
38. Nelsen, M. P.*, W. A. DiMichele, S. E. Peters, **C. K. Boyce**. 2016. Delayed fungal evolution did not cause the Paleozoic peak in coal production. *Proceedings of the National Academy of Sciences USA* 113: 2442-2447.
37. **Boyce, C. K.**, W. A. DiMichele. 2016. Arborescent lycopsid productivity and lifespan: Constraining the possibilities. *Review of Palaeobotany & Palynology* 227: 97-110.
36. Zwieniecki, M. A., **C. K. Boyce**. 2014. The role of cellulose fibers in *Gnetum gnemon* leaf hydraulics. *International Journal of Plant Sciences* 175:1054-1061.
35. Zwieniecki, M. A., **C. K. Boyce**. 2014. Evolution of a unique anatomical precision in angiosperm leaf venation lifts constraints on vascular plant ecology. *Proceedings of the Royal Society of London B* 281: 20132829.
34. Lee, J.-E., C. Frankenberg, C. van der Tol, J. A. Berry, L. Guanter, **C. K. Boyce**, J. B. Fisher, E. Morrow, J. R. Worden, S. Asefi, G. Badgley, S. Saatchi. 2013. Forest productivity and water stress in

- Amazonia: observations from GOSAT chlorophyll fluorescence. *Proceedings of the Royal Society of London B* 280: 20130171.
33. **Boyce, C. K.**, M. A. Zwieniecki. 2012. Leaf fossil record suggests limited influence of atmospheric CO₂ on terrestrial productivity prior to angiosperm evolution. *Proceedings of the National Academy of Sciences USA* 109: 10403-10408.
 32. Lee, J.-E., B. R. Lintner, J. D. Neelin, X. Jiang, P. Gentine, **C. K. Boyce**, J. B. Fisher, J. T. Perron, T. L. Kubar, J. Lee, J. Worden. 2012. Reduction of tropical land region precipitation variability via transpiration. *Geophysical Research Letters* 39: L19704.
 31. **Boyce, C. K.**, A. B. Leslie. 2012. The paleontological context of angiosperm vegetative evolution. *International Journal of Plant Sciences* 173: 561-568.
 30. Leslie, A. B., **C. K. Boyce**. 2012. Ovule function and the evolution of angiosperm reproductive innovations. *International Journal of Plant Sciences* 173: 640-648.
 29. Lee, J.-E., B. R. Lintner, **C. K. Boyce**, P. J. Lawrence. 2011. Land use change exacerbates tropical South American drought by sea surface temperature variability. *Geophysical Research Letters* 38: L19706.
 28. **Boyce, C. K.**, J.-E. Lee*. 2011. Could land plant evolution have fed the marine revolution? *Paleontological Research* 15: 100-105.
 27. Nicotra, A. B., A. Leigh, **C. K. Boyce**, C. S. Jones, K. J. Niklas, D. Royer, and H. Tsukaya. 2011. The evolution and functional significance of leaf shape in the angiosperms. *Functional Plant Biology* 38: 535-552.
 26. Leigh, A., M. A. Zwieniecki, F. E. Rockwell, **C. K. Boyce**, A. B. Nicotra, N. M. Holbrook. 2011. Structural and hydraulic correlates of heterophylly in *Ginkgo biloba* L. *New Phytologist* 189: 459-470.
 25. †**Boyce, C. K.**, J.-E. Lee*, T. S. Feild, T. J. Brodribb, M. A. Zwieniecki. 2010. Angiosperms helped put the rain in the rainforests: The impact of plant physiological evolution on tropical biodiversity. *Annals of the Missouri Botanical Gardens* 97: 527-540.
 †*Recipient of the W. S. Cooper Award of the Ecological Society of America*
 24. **Boyce, C. K.**, M. Abrecht, D. Zhou, P.U.P.A. Gilbert. 2010. X-ray photoelectron emission spectromicroscopic analysis of arborescent lycopoid cell wall composition and Carboniferous coal ball preservation. *International Journal of Coal Geology* 83: 146-153.
 23. Lee, J.-E.*, **C. K. Boyce**. 2010. Impact of the hydraulic capacity of plants on water and carbon fluxes in tropical South America. *Journal of Geophysical Research* 115: D23123.
 22. **Boyce, C. K.**, C. L. Hotton. 2010. *Prototaxites* was not a taphonomic artifact. *American Journal of Botany* 79: 1073.
 21. **Boyce, C. K.**, J.-E. Lee*. 2010. An exceptional role for flowering plant physiology in the expansion of tropical rainforests and biodiversity. *Proceedings of the Royal Society of London B* 277: 3437-3443.
 20. **Boyce, C. K.** 2010. The evolution of plant development in paleontological context. *Current Opinion in Plant Biology* 13: 102-107.
 19. Hobbie, E. A., **C. K. Boyce**. 2010. Carbon sources for the Paleozoic giant fungus *Prototaxites* inferred from modern analogues. *Proceedings of the Royal Society of London B* 277: 2149-2156.
 18. **Boyce, C. K.**, T. J. Brodribb, T. S. Feild, M. A. Zwieniecki. 2009. Angiosperm leaf vein evolution was physiologically and environmentally transformative. *Proceedings of the Royal Society of London B* 276: 1771-1776.
 17. **Boyce, C. K.** 2009. Seeing the forest with the leaves—clues to canopy placement from leaf fossil size and venation characteristics. *Geobiology* 7: 192-199.
 16. **Boyce, C. K.** 2008. The fossil record of plant physiology and development—What leaves can tell us. *Paleontological Society Papers* 14: 133-146.

15. **Boyce, C. K.** 2008. How green was *Cooksonia*? -- the importance of size in understanding the early evolution of physiology in the vascular plant lineage. *Paleobiology* 34: 179-194.
14. **Boyce, C. K.**, C. L. Hotton, M. L. Fogel, G. D. Cody, R. M. Hazen, A. H. Knoll, F. M. Hueber. 2007. Devonian landscape heterogeneity recorded by a giant fungus. *Geology* 35: 399-402.
13. **Boyce, C. K.** 2007. Mechanisms of laminar growth in morphologically convergent leaves and flower petals. *International Journal of Plant Science* 168: 1151-1156.
12. Zwieniecki, M. A., H. Stone, A. Leigh, **C. K. Boyce**, N. M. Holbrook. 2006. Hydraulic design of pine needles: one-dimensional optimization for single-vein leaves. *Plant, Cell & Environment* 29: 803-809.
11. **Boyce, C. K.** 2005. The evolutionary history of roots and leaves. Pp. 479-499 in N. M. Holbrook & M. A. Zwieniecki, eds. *Vascular transport in plants*. Elsevier Sciences/Academic Press.
10. **Boyce, C. K.** 2005. Patterns of segregation and convergence in the evolution of fern and seed plant leaf morphologies. *Paleobiology* 31: 117-140.
9. Zwieniecki, M. A., **C. K. Boyce**, N. M. Holbrook. 2004. Functional design space of single veined leaves: role of tissue hydraulic properties in constraining leaf size and shape. *Annals of Botany* 94: 507-513.
8. **Boyce, C. K.**, M. A. Zwieniecki, G. D. Cody, C. Jacobsen, S. Wirick, A. H. Knoll, N. M. Holbrook. 2004. Evolution of xylem lignification and hydrogel transport regulation. *Proceedings of the National Academy of Sciences USA* 101: 17555-17558.
7. Zwieniecki, M. A., **C. K. Boyce**, N. M. Holbrook. 2004. Hydraulic limitations imposed by crown placement determine final size and shape of *Quercus rubra* L. leaves. *Plant, Cell & Environment* 27: 357-365.
6. **Boyce, C. K.**, G. D. Cody, M. L. Fogel, R.M. Hazen, C. M. O'D. Alexander, A. H. Knoll. 2003. Chemical evidence for cell wall lignification and the evolution of tracheids in Early Devonian plants. *International Journal of Plant Sciences* 164: 691-702.
5. Zwieniecki, M. A., P. J. Melcher, **C. K. Boyce**, L. Sack, N. M. Holbrook. 2002. Hydraulic architecture of leaf venation in *Laurus nobilis* L. *Plant, Cell & Environment* 25: 1445-1450.
4. **Boyce, C. K.**, G. D. Cody, M. Feser, C. Jacobsen, A. H. Knoll, S. Wirick. 2002. Preservation of cell wall chemistry and microstructure in plant fossils as old as 400 million years: detection by carbon X-ray absorption spectromicroscopy. *Geology* 30: 1039-1042.
3. **Boyce, C. K.**, A. H. Knoll. 2002. Evolution of developmental potential and the multiple independent origins of leaves in Paleozoic vascular plants. *Paleobiology* 28: 70-100.
2. **Boyce, C. K.**, A. H. Knoll, R. M. Hazen. 2001. Nondestructive, in situ, cellular-scale mapping of elemental abundances including organic carbon in permineralized fossils. *Proceedings of the National Academy of Sciences USA* 98: 5970-5974.
1. Kirschvink, J. L., S. Padmanabha, **C. K. Boyce**, J. Oglesby. 1997. Measurement of the threshold sensitivity of honeybees to weak, extremely low-frequency magnetic fields. *Journal of Experimental Biology* 200: 1363-1368.

Other Publications

3. **Boyce, C. K.** In preparation. A wedge to lift the sky—Three billion years of life on land. Princeton University Press.
2. **Boyce, C. K.** 2015. Fossils. *Oxford Bibliographies in Evolutionary Biology*.
1. **Boyce, C. K.** 2014. C. Kevin Boyce. Pp. 25-30. In M. R. Sánchez-Villagra, and N. MacLeod, eds. *Issues in Paleobiology: A global view. Interviews and Essays*. Scidinge Hall Verlag, Zürich.