

## Paul J. Rushton



Associate Professor  
Department of Biology and Microbiology  
South Dakota State University,  
E-mail: paul.rushton@sdstate.edu

### EDUCATION

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|-------------------------------|--------------|------|
| • University of Cambridge, UK | Biochemistry | B.A. |
| • Manchester University, UK   | Biochemistry | Ph.D |

### EMPLOYMENT HISTORY

- Associate Professor 2013- present  
Texas A&M AgriLife Research & Extension Center Dallas
- Associate Professor 2009-2013  
Department of Biology and Microbiology, South Dakota State University, USA
- Research Assistant Professor 2008-2009  
University of Virginia, Department of Biology, USA
- Research Associate 2005-2008  
University of Virginia, Department of Biology, USA
- Visiting Scientist 2003-2005  
University of Oxford, Department of Plant Sciences, UK
- Independent Scientist 2001-2003  
Max-Planck-Institute for Plant Breeding, Cologne, Germany
- Senior Postdoctoral Fellow 1996-2001  
Max-Planck-Institute for Plant Breeding, Cologne, Germany
- Postdoctoral Fellow 1993-1996  
Max-Planck-Institute for Plant Breeding, Cologne, Germany
- Postdoctoral Research Associate 1988-1993  
University of Bristol, Long Ashton Research Station, UK

### MAJOR PROFESSIONAL ACTIVITIES

- Defined and named the WRKY family of plant transcription factors
- Defined and named the W box family of *cis*-acting elements
- Part of the team that annotated the first moss genome sequence, *Physcomitrella patens*.
- Provided the first evidence that WRKY transcription factors play crucial roles in plants responses to diseases
- Constructed synthetic promoters that direct local gene expression by pathogens (an important advance in attempts to engineer plants with increased disease resistance)

- Isolated, annotated and performed phylogenetic analysis on over 2,500 tobacco transcription factor genes.
- Designed and realised *TOBFAC: The tobacco transcription factors database*. A resource for all tobacco researchers (<http://compsysbio.achs.virginia.edu/tobfac/>).
- Produced The Database of *Brachypodium distachyon* WRKY Transcription factors. (<http://www.igece.org/WRKY/BrachyWRKY/BrachyWRKYIndex.html>).

## **SYNERGISTIC ACTIVITIES**

- Became an Associate Editor of *BMC Genomics* (August 2011).
- Member of the Advisory Board of *Plant Molecular Biology* 1998-2002.
- Reviewed manuscripts for *MPMI*, *The Plant Cell*, *Gene*, *Plant Molecular Biology*, *The Plant Journal*, *B.B.A.*, *Plant Physiology*, *Trends in Plant Science*, *Planta*, *Plant Cell and Environment*, *Physiologia Plantarum* and many others.
- Invited speaker at the Plant Science Conference at Dabringhausen 2001.
- Invited speaker at the 4th International Workshop on PR proteins in plants. Irsee, Germany.
- Invited speaker at 4th *Solanaceae* Genome Conference, Jeju Korea, September 2007.
- Invited speaker at the Plant and Animal Genome XVI, San Diego CA, January 2008.
- Chaired the tobacco session at 5th *Solanaceae* Genome Conference, Cologne, Germany, September 2008.
- Invited speaker at Plenary Session (genomics and bioinformatics) at 5th *Solanaceae* Genome Conference, Cologne, Germany, September 2008.
- Invited to chair the *Solanaceae* session at the Plant and Animal Genome XVII, San Diego CA, January 2009.
- Invited speaker at the Plant and Animal Genome XVIII, San Diego CA, January 2010.
- Invited to edit a special issue of the journal *Agronomy* entitled "Utilization of Genetic Resources and Emerging -Omics Technologies to Expand Agro-ecological Adaptation of Crops"  
[http://www.mdpi.com/journal/agronomy/special\\_issues/genetic\\_resources\\_%20emerging\\_omics](http://www.mdpi.com/journal/agronomy/special_issues/genetic_resources_%20emerging_omics)

**Grants Received in the last five years (~\$2.02 million total award amounts)**

- 1) Rushton P.J. and Finer, J. J., *United Soybean Board*. \$50,000. 1/09 –7/10. A SURE database. Paul Rushton **\$25,000**.
- 2) Rushton, P.J. and Shen, X., *USDA*. \$348,000. 8/08-7/12. WRKY transcription factors as tools to improve drought responses. Paul Rushton approximately **\$200,000**
- 3) Finer, J.J. and Rushton, P.J. *Consortium for Plant Biotechnology Research*. \$250,000. 7/10-6/13. Novel Soybean Promoters that are Stronger than CaMV35S. Paul Rushton approximately **\$125,000**
- 4) Finer, J.J., Rushton, P.J., Dorrence, A., and Clough, S. *North Central Soybean Research Program*. \$500,000. 7/10-6/13. Characterization of promoters from soybean defense-response genes. Paul Rushton **\$103,278**
- 5) Clay, D., Li, W., Rushton, P.J., Rohila, J.S., Subramanian, S., and Gu, X. *South Dakota Soybean Research and Promotion Council*. \$149,043 rising to \$156,043 for FY 2011-2012. 2008-2012. Increased profitability through the delivery of soybean stress response genes and information to SD soybean growers and commercial and public breeders. Paul Rushton **\$25,000**, rising to **\$27,000** for FY2012
- 6) Clay, D. E., Blodgett, S., Li, W., Rushton, P. J., Rohila, J., Subramanian, S., Gu, X. Y., Gonzalez, J. *USDA* \$262,905 2009-2011. Seed technology for the identification of signaling pathways under heat and water stress. Paul Rushton **\$25,000**
- 7) Rohila, J.S., Rushton, P.J. Glover, K.D. and Schumacher, T. *S.D. Wheat Commission*. \$18,900. 2011-2012. Discovering water stress-response mechanisms by a combination of cutting-edge genomics, proteomics and biotechnology approach. Paul Rushton approximately **\$2,000**
- 8) Rushton, P.J. and Emme, N. Bentley-Griffith Award. *SDSU*. 2010-2011. Molecular identification of subspecies distribution of the big brown bat (*Eptesicus Fuscus*). **\$2,000**
- 9) Rushton, P.J., Tripathi, P. and Rabara, R.C. *USDA via the SDSU Drought Center*. 2011-2012. Using innovative seed, soil and plant technologies for improved food security in a variable climate. **\$3,000**
- 10) Rohila, J., Rushton P.J., Gonzalez, J., Gautam, S., Boe, A. *USDA/NIFA Sun Grant*. 2012-14. Gene discovery for delayed senescence in bioenergy crops to improve total biomass production. \$151,000. Paul Rushton approximately **\$75,000**

**Patents and Invention Disclosures (selected)**

- 1) **U.S. Patent Application Serial No. 12/676,867** filed on March 5, 2010  
Entitled “Compositions and Related Methods for Modulating Transcriptional Activation by Incorporating Gag Motifs Upstream of Core Promoter Elements” Inventors Michael P. Timko, Paul J. Rushton and Marta T. Bokowiec.
- 2) **U.S. Patent Application Serial No. 12/676,871** filed on March 5, 2010  
Entitled “Compositions and Related Methods for Modulating Alkaloid Production by Controlling PMT Promoter Activation Mediated by Transcriptional Factors ERF and MYC” Inventors Michael P. Timko, Paul J. Rushton, Sheng-Cheng Han, Hongbo Zhang and Marta T. Bokowiec
- 3) **European Patent Application EP1637607** filed on 11/12/1999. Entitled “Chimeric promoters capable of mediating gene expression in plants upon pathogen infection and uses thereof.” Rushton, Paul, Somssich, Imre E., Logemann, Elke, Halbrock, Klaus, and Kirsch, Christoph.
- 4) **World Intellectual Property Organization WO 2000/029592 patent**. filed May 2000. Entitled “Chimeric promoters capable of mediating gene expression in plants upon pathogen infection and uses thereof.” Kirsch Christoph, Logemann Elke, Hahlbrock Klaus, Rushton Paul, Somssich Imre.

## PUBLICATIONS

- 37) Prateek Tripathi, Roel C Rabara, and Paul J Rushton. A systems biology perspective on the role of WRKY transcription factors in drought responses in crops. Submitted to *Critical Reviews in Biotechnology*.
- 36) Sears, M.T., Zhang, H., Rushton, P. J., Kudithipudi, C., Han, S., Spano, A., Hayes, A., Timko, M. P. (2012) NtERF2, a non-NIC locus AP2/ERF transcription factor that activates early jasmonate responses of nicotine biosynthesis gene expression in tobacco. *Plant Molecular Biology* (in revision).
- 35) Prateek Tripathi, Roel C. Rabara, Jun Lin and Paul J. Rushton (2013). GmWRKY53, a water- and salt-inducible soybean gene for rapid dissection of regulatory elements in BY-2 cell culture. *Plant Signaling & Behavior* 8 (5) eLocation ID: e24097
- 34) Prateek Tripathi, Roel C Rabara, and Paul J Rushton (2012). Emergence of omics-approaches for crop improvement during abiotic stress. *International Journal of Environmental Science and Technology*. 1(2):125-128.
- 33) Roel C Rabara, Prateek Tripathi, Jun Lin, and Paul J Rushton (2012). Dehydration-Induced WRKY Genes from Tobacco and Soybean Respond to Jasmonic Acid Treatments in By-2 Cell Culture. *Biochemical and Biophysical Research Communications*. 01/2013; DOI:doi: 10.1016/j.bbrc.2012.12.156.
- 32) Prateek Tripathi, Roel C. Rabara, Tanner J. Langum, Ashley K. Boken, Deena L. Rushton, Darius D. Boomsma, Charles I. Rinerson, Jennifer Rabara, R. Neil Reese, Xianfeng Chen, Jai S. Rohila, and Paul J. Rushton (2012). The WRKY transcription factor family from *Brachypodium distachyon*. *BMC Genomics* 13:270. Impact factor 4.07
- Highly accessed
- 31) Maurice HT Ling, Roel C Rabara, Prateek Tripathi, Paul J Rushton, and Xijin Ge. Extending MapMan Ontology to Tobacco for Visualization of Gene Expression. *Dataset Papers in Bioinformatics* (Published 30<sup>th</sup> July 2012. E-pub ahead of print <http://www.datasets.com/journals/biology/aip/706465/>).
- 30) Rushton, D.L., Tripathi, P., Rabara, R.C., Lin, J., Ringler, P., Boken, A.K., Langum, T.J., Smidt, L., Boomsma, D.D., Emme, N.J., Chen, X., Finer, J.J., Shen, Q.J., and Rushton P.J. (2011) WRKY transcription factors: key components in abscisic acid signalling. *The Plant Biotechnology Journal*. 10(1):2-11. Impact factor 5.44
- 29) Zhang, H., Bokowiec, M.T., Rushton, P.J., Han, S., and Timko, M.P. (2011) Tobacco Transcription Factors NtMYC2a and NtMYC2b Form Nuclear Complexes with the NtJAZ1 Repressor and Regulate Multiple Jasmonate-inducible Steps in Nicotine Biosynthesis. *Molecular Plant*. 5(1) 73-84. I. factor 5.54
- 28) Roy, A., Rushton, P.J., and Rohila, J.S. (2011) The Potential of Proteomic Technologies for Crop Improvement under Drought Environments. *Critical Reviews in Plant Science*. 30:5, 471-490. Impact factor 3.82
- 27) Hernandez-Garcia, C.M., Bouchard, R.A., Rushton, P.J., Jones, M.L., Chen, X., Timko, M.P., and Finer, J.J. (2010) High level transgenic expression of soybean (Glycine max) GmERF and Gmubi gene promoters isolated by a novel promoter analysis pipeline. *BMC Plant Biology* 10:237. Impact factor 3.45
- Highly accessed
- 26) Timko, M.P., Rushton, P.J., Bokowiec, M.T., and Zhang, H. (2010) Functional genomic approaches to harm reduction in tobacco products. In: Robertson R, Robinson E, and Siminszky B (eds.), *Recent Advances in Tobacco Science*, Vol. 36, Tobacco Research in the Era of Biotechnology and Genomics,

Proceedings 64th Tobacco Science Research Conference. Tobacco Science Research Conference Communication Services, pp. 25-43.

25) [Rushton, P.J.](#), Somssich, I.E., Ringler, P., and Shen, J. (2010) WRKY transcription factors. *Trends in Plant Science* 15, 247-58. [Impact factor 11.04](#)

24) [Rushton, P.J.](#), Bokowiec, M.T., Han, S., Zhang, H., Chen, X., Laudeman, T.W., Brannock, J.F. and Timko, M.P. (2008) Tobacco transcription factors. *Plant Physiology*, 147(1): 280-95. [Impact factor 7.05](#)

23) Michael P. Timko, [Paul J. Rushton](#), Thomas W. Laudeman, Marta T. Bokowiec, Edmond Chipumuro, Foo Chueng, Christopher D. Town, and Xianfeng Chen (2008) Sequencing and Analysis of the Gene-Rich Space of Cowpea. *BMC Genomics* 9:103. [Impact factor 4.07](#)

22) Stefan A. Rensing, Daniel Lang, Andreas Zimmer, Astrid Terry, Asaf Salamov, Harris Shapiro, Tomoaki Nishiyama, Pierre-François Perroud, Erika Lindquist, Yasuko Kamisugi, Takako Tanahashi, Keiko Sakakibara, Tomomichi Fujita, Kazuko Oishi, Tadasu Shin-I, Yoko Kuroki, Atsushi Toyoda, Yutaka Suzuki, Shinichi, Hashimoto, Kazuo Yamaguchi, Sumio Sugano, Yuji Kohara, Asao Fujiyama, Aldwin Anterola, Setsuyuki Aoki, Neil Ashton, W. Brad Barbazuk, Elizabeth Barker, Jeffrey Bennetzen, Robert Blankenship, Sung Hyun Cho, Susan Dutcher, Mark Estelle, Jeffrey A. Fawcett, Heidrun Gundlach, Kosuke Hanada, Alexander Heyl, Karen A. Hicks, Jon Hughes, Martin Lohr, Klaus Mayer, Alexander Melkozernov, Takashi Murata, David Nelson, Birgit Pils, Michael Prigge, Bernd Reiss, Tanya Renner, Stephane Rombauts, [Paul J. Rushton](#), Anton Sanderfoot, Gabriele Schween, Shin-Han Shiu, Kurt Stueber, Frederica L. Theodoulou, Hank Tu, Yves Van de Peer, Paul J. Verrier, Elizabeth Waters, Andrew Wood, Lixing Yang, David Cove, Andrew C. Cuming, Mitsuyasu Hasebe, Susan Lucas, Brent D. Mishler, Ralf Reski, Igor Grigoriev, Ralph S. Quatrano, Jeffrey L. Boore. (2008).

The genome of the moss *Physcomitrella patens* reveals evolutionary insights into the conquest of land by plants. *Science* 319:64-9 (Published online December 13<sup>th</sup> 2007. DOI: 10.1126/science.1150646). [Impact factor 29.78](#)

21) [Rushton, P.J.](#), Bokowiec, M.T., Laudeman, T.W., Brannock, J.F., Chen, X., and Timko, M.P. (2008) TOBFAC: The database of tobacco transcription factors. *BMC Bioinformatics* 9:53. [Impact factor 2.75](#)

20) Chen, X., Laudeman, T.W., [Rushton, P.J.](#), Spraggins, T.A. and Timko, M.P. (2007) CGKB: an annotation knowledge base for cowpea (*Vigna unguiculata L.*) methylation filtered genomic genespace sequences. *BMC Bioinformatics* 8:129. [Impact factor 2.75](#)

19) Gurr, S.J. and [Rushton, P.J.](#) (2005)a Engineering plants with increased disease resistance: What are we going to express? *Trends in Biotechnology* 23: 275-282.

18) Gurr, S.J. and [Rushton, P.J.](#) (2005)b Engineering plants with increased disease resistance: How are we going to express it? *Trends in Biotechnology* 23: 283-290.

17) [Rushton, P.J.](#) (2002) Exciting prospects for plants with greater disease resistance. *Trends in Plant Science* 7. 325.

16) [Rushton, P.J.](#), Reinstädler, A., Lipka, V., Lippok, B., Hahlbrock, K. and Somssich, I.E. (2002) Synthetic plant promoters containing defined regulatory elements provide novel insights into pathogen- and wound-induced signalling. *Plant Cell* 14: 749-762.

[This work was the subject of the following commentary:](#)

Synthetic promoters illuminate roles of cis-acting elements in plant defence. (2002) *Trends in Plant Science* 7. 315

15) Cormack, R.S., Eulgem, T., [Rushton, P.J.](#), Köchner, P., Hahlbrock, K. and Somssich, I.E. (2002) Leuzine zipper containing WRKY proteins widen the spectrum of immediate early elicitor-induced WRKY transcription factors in parsley. *Biochimica et Biophysica Acta* 1576: 92-100.

14) [Rushton, P.J.](#) and Weißhaar, B. (2002) DNA-protein interactions. In: *Molecular Plant Biology Volume 2: A Practical Approach* (Gilmartin, P. and Bowler, C. eds.) Oxford University Press. Pp. 77-95.

- 13) Eulgem, T., Rushton, P.J., Robatzek, S. and Somssich, I.E. (2000) The WRKY superfamily of plant transcription factors. *Trends in Plant Science* 5: 199-206. [Cited over 1,070 times according to Google Scholar, this was the second most cited review to come from the Max-Planck Society in 2000.](#)
- 12) Eulgem, T., Rushton, P.J., Schmelzer, E., Hahlbrock, K. and Somssich, I.E. (1999) Early nuclear events in plant defense signaling: rapid gene activation by WRKY transcription factors. *EMBO J.* 18: 4689-4699.
- 11) Rushton, P.J. and Somssich, I.E. (1999) Transcriptional regulation of plant genes responsive to pathogens and elicitors. In: *Plant-Microbe Interactions Vol. 4* (Stacey, G. and Keen, N. eds.), APS Press, pp. 251-274.
- 10) Rushton, P.J. and Somssich, I.E. (1998) Transcriptional control of plant genes responsive to pathogens. *Curr. Opin. Plant Biol.* 1: 311-315.
- 9) Willmott, R.L., Rushton, P.J., Hooley, R. and Lazarus, C.M. (1998) DNase1 footprints suggest the involvement of at least three types of transcription factors in the regulation of  $\alpha$ -Amy2/A by gibberellin. *Plant Molecular Biology* 38: 817-825.
- 8) Rushton, P.J., Torres, J.T., Parniske, M., Wernert, P., Hahlbrock, K. and Somssich, I.E. (1996) Interaction of elicitor-induced DNA-binding proteins with elicitor response elements in the promoters of parsley PR1 genes. *EMBO J.* 15: 5690-5700. [This landmark paper has been cited over 400 times.](#)
- 7) Rushton, P.J., Macdonald, H., Huttly, A.K., Lazarus, C.M. and Hooley, R. (1995) Members of a new family of DNA-binding proteins bind to a conserved *cis*-element in the promoters of  $\alpha$ -Amy2 genes. *Plant Molecular Biology* 29: 691-702.
- 6) Hooley, R., Beale, M.H., Smith, S.J., Walker, R.P., Rushton, P.J., Whitford P.N. and Lazarus, C.M. (1992b) In: *Transport and Receptor Proteins of Plant Membranes: Molecular structure and Function*, (Cooke, D.T. and Clarkson, D.T. eds.) Plenum Press, New York, pp.157-167.
- 5) Hooley, R., Beale, M.H. Smith, S.J. Walker, R.P., Rushton, P.J., Whitford P.N. and Lazarus, C.M. (1992a) Gibberellin perception and the Avena fatua aleurone – Do our molecular keys fit the correct locks? *Biochemical Society Transactions* 20: 85-89.
- 4) Rushton, P.J., Hooley, R. and Lazarus, C.M. (1992) Aleurone nuclear proteins bind to similar elements in the promoter regions of 2 gibberellin-regulated  $\alpha$ -amylase genes. *Plant Molecular Biology* 19: 891-901.
- 3) Bray, C.M. Blowers, L.E., Rushton, P.J. and Smith, C.A.D. (1992) In: *Advances in the Science and Technology of Seeds* (Fu, J.R. and Khan, A.A. eds.) Science Press, Beijing and New York, pp 91-97.
- 2) Rushton, P.J. and Bray, C.M. (1987) Stored and de novo synthesised polyadenylated RNA and loss of vigor and viability in wheat seed. *Plant Science* 51: 51-59.
- 1) Smith, C.A.D., Rushton, P.J. and Bray, C.M. (1986) Polyadenylated RNA-metabolism and loss of vigor and viability in germinating wheat embryos. *Physiologia Plantarum* 67: 310-314.

### Outreach Publications

**Rushton, P.J.**, Li, W., and Hansen, S. (2011) Using Molecular Biology for Management and Genetic Enhancements. In *iGrow wheat*, South Dakota State University, College of Agriculture and Biological Sciences, AgBio Communications Unit, Brookings, South Dakota.