Nathan R. Johnson

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HIGHLIGHTS

- Broadly trained and motivated scientist interested in computational biology in plants.
- Extensive experience in public speaking and scientific presentation.
- Skilled in computational biology with an emphasis on problem solving.
- Successfully completed 3 projects to publication during Ph.D. training, including a publication in Nature.
- Strong background in molecular biology and experimentation in plants.

EDUCATION

Ph.D. Plant Biology 2014-present
Penn State University, University Park, PA
Advisor: Mike Axtell

B.S. Plant Biology 2006-2011
Michigan State University, East Lansing, MI
Advisor: Sheng-Yang He

WORK EXPERIENCE

Laboratory Technologist / Manager 2011-2014
Great Lakes Bioenergy Research Center
PI: Curtis Wilkerson

Undergraduate Laboratory Assistant 2009-2011
Plant Research Laboratory
PI: Sheng-Yang He

RECENT AND CURRENT RESEARCH

Investigation of sRNAs in Parasitic Plants

Small regulatory RNAs (sRNAs) are thought to function in *trans*-species regulation between host and parasite/pathogen. Our work examined this system in parasitism by the noxious weed *Cuscuta campestris*, finding numerous micro RNAs (miRNAs) which regulate host mRNAs. Recent work has looked broadly at the *Cuscuta* genus, finding

that the parasite produces a broad spectrum of sRNAs which can target host mRNAs. Furthermore, this provides an evolutionary paradigm by which the parasite can maintain targeting in-spite of host adaptation.

Tool development in sRNA-sequencing

Alignment and annotation of sRNA-seq data suffers from high-rates of ambiguously mapping reads. Methods in the field inadequately solved this problem, leading us to implement algorithms for estimating read alignment in our lab's tool: ShortStack. Testing against simulated and real data show that this new method in ShortStack is much more precise in aligning miRNAs and small interfering RNAs than other available methods.

RESEARCH EXPERIENCE

Computational Biology

- Developed numerous custom data analysis pipelines spanning and interacting in multiple programming languages (Python, R, mysql, perl, C++). This includes scripting and experimental testing to validate their results.
- Surveyed and compared the qualities of numerous software packages, identifying the proper tools for my purposes.
- Performed differential expression analysis on both sRNA-seq and mRNA-seq, including thoughtful data presentation.
- Designed and implemented clustering algorithms to de-convolute and extract related elements from sequencing data.
- Developed scripts to simulate highly realistic sequencing data, which was used for experimental validation in several projects.
- Created automated pipelines for clear data presentation of large/complicated datasets (300+ figures) and advanced graphics using R.
- Performed phylogenetic analysis for species identification and gene-family analysis.
- Performed benchmarking of numerous bioinformatic tools for sequence alignment, testing numerous qualities related to performance and speed.

Molecular and Protein Biology

- Developed and troubleshooted home-brewed sRNA-seq library preparation procedures, producing 100+ libraries at significantly reduced cost.
- Prepared 60+ mRNA-seq and specialized degradome libraries using modern tagmentation based procedures.
- Highly proficient with molecular biological techniques (RNA extraction and purification, nucleic acid synthesis and purification, cDNA-library preparation, quantitative PCR, vector design and cloning, northern and western blots) and plant-based genetic engineering (stable/transient *Agrobacterium*-mediated transformation and selection).
- Optimized expression of recombinant protein (20+ vectors) in *E. coli*, yeast and transiently in plants.

- Purified proteins using high-pressure liquid chromatography.

Plant Growth and Analysis

- Developed methods for growing the parasitic plant *Cuscuta*, including the design and construction of LED supplementary lighting required for survival.
- Refined assays for sampling *Cuscuta* and host tissue for use in sequencing and other experiments.
- Developed assays for phenotyping and quantifying the health of *Cuscuta* and host during parasitism.
- Experienced in care and propogation for a wide variety of plants.

Other Experience

- Experienced with confocal and epifluorescence microscopy of plant anatomical structures.
- Produced and designed custom 3d-printed laboratory equipment for plant growth, microscopy and other bench-work.
- Designed, built, and programmed arduino-based automated sensor systems for measurement of plant hydration.
- Used Raspberry Pi-based systems for time-lapse photography of plant growth, including *Cuscuta* parasitism.

PUBLICATIONS

7. NR Johnson, CW dePamphilis, and MJ Axtell, "Compensatory sequence variation between trans-species small RNAs and their target sites", *BioRxiv* (2019) - **Preprint**
6. NR Johnson, and MJ Axtell, "Small RNA warfare: exploring origins and function of *trans*-species microRNAs from the parasitic plant *Cuscuta*", *Curr. Opin. Plant Biology* (2019) - **Review**
5. S Shahid, G Kim, NR Johnson, E Wafula, F Wang, C Coruh, V Bernal-Galeano, T Phifer, CW dePamphilis, JH Westwood, and MJ Axtell, "MicroRNAs from the parasitic plant *Cuscuta campestris* target host messenger RNAs", *Nature* (2018) - **Research**
4. F Wang, NR Johnson, C Coruh, and MJ Axtell, "Genome-wide analysis of single non-templated nucleotides in plant endogenous siRNAs and miRNAs", *Nucleic Acids Res.* (2016) - **Research**
3. NR Johnson, J Yeoh, C Coruh, and MJ Axtell, "Improved Placement of Multi-Mapping Small RNAs", *G3* (2016) - **Research**
2. JK Jensen, NR Johnson, and CG Wilkerson, "*Arabidopsis thaliana* IRX10 and two related proteins from psyllium and Physcomitrella patens are xylan xylosyltransferases", *The Plant Journal* (2014) - **Research**
1. JK Jensen, NR Johnson, and CG Wilkerson, "Discovery of diversity in xylan biosynthetic genes by transcriptional profiling of a heteroxylan containing mucilaginous tissue", *Front. Plant Sci.* (2013) - **Research**

PRESENTATIONS

Talks

5. ASPB (mid-atlantic section) - *Univ. of Maryland* (Jun-2019)
   Surrounded by sRNAs: *Trans*-species sRNAs in the *Cuscuta* genus
4. Life Science Symposium - *Penn State Univ.* (May-2019)
   Surrounded by sRNAs: *Trans*-species sRNAs in the *Cuscuta* genus
   Invited Speaker
3. ASPB 2018 - *Montreal, QC, Canada* (Jul-2018)
   Rapid evolution of trans-species sRNAs in the genus *Cuscuta*
2. Life Science Symposium - *Penn State Univ.* (May-2018)
   Rapid evolution of trans-species sRNAs in the genus *Cuscuta*
1. Plant Biology Colloquium - *Penn State Univ.* (Feb-2016)
   Insights into Small RNA Sequencing Alignment

Posters

10. World Congress on Parasitic Plants - *Amsterdam, Netherlands* (Jul-2019)
    Surrounded by sRNAs: *Trans*-species sRNAs in the *Cuscuta* genus
    Best Poster Award Recipient
9. ICAR 2017 - *St.Louis, MO* (Apr-2017)
   MicroRNAs from the parasitic plant *Cuscuta campestris* target host messenger RNAs
8. ASPB 2016 - *Austin, TX* (Jul-2016)
   ShortStack3: Improving Alignment of Small RNAs Through Superior Multi-Mapper Placement
7. ASPB (Mid-Atlantic Section) - *Swarthmore College* (Apr-2016)
   ShortStack3: Improving Alignment of Small RNAs Through Superior Multi-Mapper Placement
   Marsho Award Recipient
6. ASPB 2015 - *Minneapolis, MN* (Jul-2015)
   Advancements in small RNA-seq alignment methods for ambiguously mapped reads
5. 20th Plant Biology Symposium - *Penn State Univ.* (May-2015)
   Strategies for aligning small RNA sequencing data
4. ASPB (Mid-Atlantic Section) - *Swarthmore College* (Apr-2015)
   Strategies for aligning small RNA sequencing data
3. GLBRC - Annual Retreat Poster Forum - *South Bend, IN* (May-2013)
   Efforts to Identify Transcription Factors Regulating Mixed-Linkage Glucan Biosynthesis

2. GLBRC - Annual Retreat Poster Forum - *South Bend, IN* (May-2012)
   Investigating the Role of Transcription Factor KNAT7 in the Regulation of Xylan Biosynthesis

1. University Undergraduate Research and Arts Forum - *Michigan State Univ.* (Apr-2011)
   Positively Charged Amino Acid Motifs Crucial to *A. thaliana JAZ3* Function and Jasmonic Acid Signaling

AWARDS

- 2019 Best Poster Award, World Congress on Parasitic Plants
  Poster selected as one of two best posters among 40+ eligible posters (€300).
- 2019 Invited speaker, Huck Institutes
  Talk selected among 50+ applicants to be featured for a university-wide Life Science Symposium ($300).
- 2017 Huck Graduate Research Innovation Grant, Huck Institutes
  Awarded for original research proposals. Intended for proposals conceived and written without involvement of one's graduate advisor ($5,000).
- 2017 J. Ben and Helen D. Hill Memorial Fund Award
  Award covers expenses for the presentation of work at a scientific conference ($1,500).
- 2016 Marsho Award, ASPB Mid-Atlantic section
  Awarded to best graduate student or post-doctoral poster presentation ($150).

TEACHING

- April 2018: **BIOL 407 - Plant Developmental Anatomy - guest lecture**
  Lectured upper-level Undergraduate students on the anatomy and physiology of *Cuscuta* and parasitic plants on the whole.
- Fall 2016 and 2017: **BIOL 110 – Basic concepts and Biodiversity**
  Lectured to two laboratory sections, one comprised of students from the honors college. Prepared weekly presentations, led the class in laboratory exercises and provided thorough critique of writing work. Course work covered introductory laboratory techniques with a focus on biodiversity, cellular replication and basic genetics.
- Spring 2016: **BIOL 240 – Function and Development of Organisms**
  Lectured to two laboratory sections. Prepared weekly presentations, led the class in laboratory exercises and provided thorough critique of writing work. Course work covered introductory laboratory techniques with a focus on animal and plant physiology and development.

MENTORSHIP

Penn State University (2014-present)

- Advised four undergraduate students in independent research projects, three of which were participating in an NSF-funded summer-REU project. These projects frequently had published outcomes, with two students receiving inclusion as authors on a published work.
- Acted as official mentor of three students in the Plant Biology Ph.D. program, providing help and insight with their progress through graduate school.

Michigan State University (2011-2014)

- Advised one undergraduate student in an independent research project as a part of a summer-REU program.
- Trained three undergraduates in laboratory operation, including numerous techniques, instrument operation and plant care.

OUTREACH AND SERVICE

- Exploration-U (Feb-2017)
  Participated in a local school district's science outreach event. Engaged young students in plant biology.
- Hosted Charter School for Laboratory Field Trip (Nov-2015)
  Organized and coordinated demonstrations for local elementary and middle school students. Demonstrations included laboratory presentations in microscopy, evolution and general science interest.
- Judge for Undergraduate Poster Fair - PSU (Oct-2015)
  Provided feedback and critiqued undergraduate posters, advancing the student's science education.
- Judge for Pennsylvania Junior Academy of Sciences - PSU (May-2015/16/17)
  Participated as a judge for groups of middle and high school students in their championship-level competition. Critiqued and encouraged young scientists as they presented research projects and results. Participated for three years, 2015-2017