

# Frank O. Aylward, PhD

*Curriculum Vitae*

Assistant Professor  
Department of Biological Sciences  
Virginia Tech  
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## EDUCATION

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- 2008-2013      PhD in *Microbiology*, Microbiology Doctoral Training Program, **University of Wisconsin-Madison**, Madison, WI. Awarded in August 2013.
- 2004-2008      B.Sc., double-major in *Biochemistry and Molecular Biophysics* and *Molecular and Cellular Biology*, **University of Arizona**, Tucson, Arizona.

## ACADEMIC POSITIONS & RESEARCH EXPERIENCE

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- 2017-      **Assistant Professor.** Department of Biological Sciences, Virginia Tech, Blacksburg, VA.
- 2014-2017      **Postdoctoral Researcher.** Advisor: Edward F. DeLong, Center for Microbial Oceanography Research and Education, **University of Hawai'i at Mānoa**, Honolulu, HI.
- 2013-2014      **Postdoctoral Researcher.** Advisor: Edward F. DeLong, Department of Civil and Environmental Engineering, **Massachusetts Institute of Technology**, Cambridge, MA.
- 2008-2013      **PhD Candidate.** Advisor: Cameron Currie, Department of Bacteriology & Great Lakes Bioenergy Research Center (GLBRC), **University of Wisconsin-Madison**, Madison, WI.
- 2006-2008      **Undergraduate Researcher.** Advisor: Howard Ochman, Department of Biochemistry and Molecular Biophysics, **University of Arizona**, Tucson, AZ.
- 2005-2006      **Undergraduate Researcher.** Advisor: Rick Michod, Department of Ecology and Evolutionary Biology, **University of Arizona**, Tucson, AZ.

## ACADEMIC HONORS, AWARDS, & SCHOLARSHIPS

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- 2019      Luther and Alice Hamlett Endowed Junior Faculty Fellowship
- 2019      Outstanding Research Award, Department of Biological Sciences, Virginia Tech
- 2019      Simons Foundation Early Career Award in Marine Microbial Ecology and Evolution
- 2018      Alfred P. Sloan Research Fellowship in Ocean Sciences
- 2012      International Society for Microbial Ecology Travel Grant (Copenhagen, DK)
- 2012      Wisconsin Distinguished Graduate Fellowship, University of Wisconsin-Madison
- 2011      Hopkins Microbiology Course Fellowship (Pacific Grove, CA)
- 2009      Honorable mention, Graduate Research Fellowship Program, NSF
- 2007      Van de Velde Undergraduate Research Scholarship, University of Arizona
- 2006      Galileo Circle Undergraduate Research Scholarship, University of Arizona

## PUBLICATIONS

Full citation information can be found on [Google Scholar](#)

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\* Co-first author; # Graduate or Undergraduate mentee; ± Corresponding author.

### *Peer-reviewed original research articles*

1. M Moniruzzaman, CA Martinez-Gutierrez<sup>#</sup>, AR Weinheimer<sup>#</sup>, **FO Aylward**<sup>±</sup>. Dynamic genome evolution and complex virocell metabolism of globally-distributed giant viruses. *Nature Communications*, 2020, 11(1): 1-11.
2. AM Linz, **FO Aylward**, S Bertilsson, KM McMahon. Time-series metatranscriptomes reveal conserved patterns between phototrophic and heterotrophic microbes in diverse freshwater systems. *Limnology and Oceanography*, 2020, 65:101-112.
3. ED Osburn, SG McBride, **FO Aylward**, BD Badgley, BD Strahm, JD Knoop, JE Barrett. Soil bacterial and fungal communities exhibit distinct long-term responses to disturbance in temperate forests. *Frontiers in Microbiology*, 2019, 10.
4. CA Martinez-Gutierrez<sup>#</sup> & **FO Aylward**<sup>±</sup>. Strong purifying selection is associated with genome streamlining in epipelagic *Marinimicrobia*. *Genome Biology and Evolution*, 2019, 11 (10), 2887-2894.
5. BC Kolody, JP McCrow, L Zeigler Allen, **FO Aylward**, KM Fontanez, A Moustafa, M Moniruzzaman, FP Chavez, CA Scholin, EE Allen, AZ Worden, EF DeLong, AE Allen. Diel transcriptional response of a California Current plankton microbiome to light, low iron, and enduring viral infection. *ISME J*, 2019, 13(11): 2817-2833.
6. MJ Harke, FR Frischkorn, ST Haley, **FO Aylward**, JP Zehr, ST Dyhrman. Periodic and coordinated gene expression between a diazotroph and its diatom host. *ISME J*, 2019, 13(1):118-131.
7. EW Getz, SS Tithi, L Zhang, **FO Aylward**<sup>±</sup>. Parallel Evolution of Genome Streamlining and Cellular Bioenergetics Across the Marine Radiation of a Bacterial Phylum. *mBio*, 2018, 9(5).
8. SS Tithi, **FO Aylward**, RJ Jensen, L Zhang. FastViromeExplorer: a pipeline for virus and phage identification and abundance profiling in metagenomics data. *PeerJ*, 2018, 12;6:e4227.
9. Luo E, **FO Aylward**, DR Mende, EF DeLong. Bacteriophage Distributions and Temporal Variability in the Ocean's Interior. *mBio*, 2017, 8(6):e01903-17.
10. **FO Aylward**, D Boeuf, DR Mende, EM Wood-Charlson, A Vislova, JM Eppley, AE Romano, EF DeLong. Diel Cycling and Long-Term Persistence of Viruses in the Ocean's Euphotic Zone. *Proceedings of the National Academy of Sciences, USA*, 2017, 114(43): 11446-11451.
11. DR Mende\*, J Bryant\*, **FO Aylward**\*, JM Eppley, TN Nielsen, DM Karl, EF DeLong. Environmental Drivers of a Microbial Genomic Transition Zone in the Ocean's Interior. *Nature Microbiology*, 2017, 2(10): 1367.
12. ST Wilson\*, **FO Aylward**\*, F Ribalet, B Barone, JR Casey, PE Connell, JM Eppley, S Ferrón, JN Fitzsimmons, CT Hayes, AE Romano, KA Turk-Kubo, A Vislova, EV Armbrust, DA Caron, MJ Church, JP Zehr, DM Karl, EF DeLong. Coordinated Regulation of Growth, Activity and Transcription in Natural Populations of the Unicellular Nitrogen-Fixing Cyanobacterium *Crocosphaera*. *Nature Microbiology*, 2017, 2(9): 118.
13. EA Gontang, **FO Aylward**, C Carlos, TG del Rio, M Chovatia, A Fern, C-C Lo, SA Malfatti, SG Tringe, CR Currie, R Kolter. Major changes in microbial diversity and community composition across gut sections of a juvenile *Panthera leo* cockroach. *PLOS ONE*, 2017, 12(5): e0177189.

14. DR Mende\*, **FO Aylward\***, JM Eppley, TN Nielsen, EF DeLong. Improving Environmental Genomes via Integration of Metagenomic and Single-Cell Assemblies. **Frontiers in Microbiology**, 2016, 7:e143.
15. JA Bryant, **FO Aylward**, JM Eppley, DM Karl, MJ Church, EF DeLong. The Influence of Wind and Solar Radiation on Microbial Community Diversity in the North Pacific Subtropical Gyre. **The ISME Journal**, 2016, 10(6):1308-1322.
16. **FO Aylward**, JM Eppley, JM Smith, FP Chavez, CA Scholin, EF DeLong. Microbial Community Transcriptional Network Dynamics are Conserved Across All Three Domains of Life at Ocean Basin Scales. **Proceedings of the National Academy of Sciences, USA**, 2015; 112(17): 5443-5448.
17. MA Spero, **FO Aylward**, CR Currie, TJ Donohue. Phylogenomic Analysis and Predicted Physiological Role of the Proton-Translocating NADH:quinone Oxidoreductase (Complex I) Across Bacteria. **mBio**, 2015; 5(6): e02077-14.
18. **FO Aylward**<sup>‡</sup>, L Khadempour, DM Tremmel<sup>#</sup>, BR McDonald, CD Nicora, S Wu, RJ Moore, DJ Orton, ME Monroe, PD Piehowski, SO Purvine, RD Smith, MS Lipton, KE Burnum-Johnson, CR Currie. Enrichment and Broad Representation of Plant Biomass-Degrading Enzymes in the Specialized Hyphal Swellings of *Leucoagaricus gongylophorus*, the Fungal Symbiont of Leaf-Cutter Ants. **PLOS ONE**, 2015; 10(8): e0134752.
19. **FO Aylward**<sup>‡</sup>, G Suen, PHW Biedermann, AS Adams, JJ Scott, SA Malfatti, T Glavina del Rio, SG Tringe, M Poulsen, KF Raffa, KD Klepzig, CR Currie. Convergent Bacterial Microbiotas in the Fungal Agricultural Systems of Insects. **mBio**, 2014; 5(6): e02077-14.
20. EL Huang\*, **FO Aylward\***, Y-M Kim, B-JM Webb-Robertson, CD Nicora, Z Hu, T Metz, MS Lipton, RD Smith, CR Currie, KE Burnum-Johnson. The Fungus Gardens of Leaf-cutter Ants Undergo a Distinct Physiological Transition During Biomass Degradation. **Environmental Microbiology Reports**, 2014; 6(4): 389-395.
21. **FO Aylward**, KE Burnum, SG Tringe, C Teiling, DM Tremmel<sup>#</sup>, J Moeller, JJ Scott, KW Barry, CD Nicora, PD Piehowski, S Malfatti, SO Purvine, LA Goodwin, RD Smith, GM Weinstock, NM Gerardo, G Suen, MS Lipton, CR Currie. *Leucoagaricus gongylophorus* Produces Diverse Lignocellulases for the Degradation of Recalcitrant Plant Polymers in the Fungus Gardens of Leaf-cutter Ants. **Applied and Environmental Microbiology**, 2013; 79(12): 3770-3778.
22. **FO Aylward**, BR McDonald, SM Adams, A Valenzuela, RA Schmidt, LA Goodwin, T Woyke, CR Currie, G Suen, M Poulsen. Comparison of 26 Sphingomonad Genomes Reveals Diverse Environmental Adaptations and Biodegradative Capabilities. **Applied and Environmental Microbiology**, 2013; 79(12): 3724-3733.
23. AS Adams\*, **FO Aylward\***, SM Adams, N Erbilgin, BH Aukema, CR Currie, G Suen, and KF Raffa. Mountain Pine Beetles Colonizing Historical, Transitional, and Naïve Host Trees are Associated With a Community of Terpenoid-degrading Bacteria. **Applied and Environmental Microbiology**, 2013; 79(11): 3468-3475.
24. MR Christopherson, G Suen, S Bramhacharya, KA Jewell, **FO Aylward**, D Mead, PJ Brumm. The Genome Sequences of *Cellulomonas fimi* and “*Cellvibrio gilvus*” Reveal the Cellulolytic Strategies of Two Facultative Anaerobes, Transfer of “*Cellvibrio gilvus*” to the Genus *Cellulomonas*, and Proposal of *Cellulomonas gilvus* sp. nov. **PLOS ONE**, 2013; 8(1): e53954.
25. **FO Aylward**, KE Burnum, JJ Scott, G Suen, SG Tringe, SM Adams, GJ Starrett<sup>#</sup>, KJ Berry, LA Goodwin, MS Lipton, CR Currie. Metagenomic and Proteomic Insights into the Fungus Gardens of Leaf-cutter Ants. **The ISME Journal**, 2012; 6(9): 1688-1702.
26. G Suen, PJ Weimer, DM Stevenson, **FO Aylward**, J Boyum, J Deneke, C Drinkwater, NN Ivanova, N Mikhailova, O Chertkov, LA Goodwin, CR Currie, D Mead, PJ Brumm. The Complete Genome Sequence of the *Fibrobacter succinogenes* S85 reveals a Cellulolytic and Metabolic Specialist. **PLOS ONE**, 2011; 6(4): e18814.

27. G Suen, JJ Scott, **FO Aylward**, SM Adams, SG Tringe, A Pinto-Tomás, CE Foster, M Pauly, PJ Weimer, K Barry, LA Goodwin, P Bouffard, L Li, J Osterberger, TT Harkins, SC Slater, TJ Donohue, CR Currie. An Insect Herbivore Microbiome with High Plant Biomass-Degrading Capacity. *PLOS Genetics*, 2010; 6(9): e1001129.
28. MD Herron, JD Hackett, **FO Aylward**, RE Michod. Triassic Origin and Early Radiation of Multicellular Volvocine Algae. *Proceedings of the National Academy Sciences, USA*, 2009; 106(9): 3254-8.

#### *Peer-reviewed review articles*

1. **FO Aylward**, CR Currie, G Suen. The Evolutionary Innovation of Nutritional Symbioses in Fungus-growing Ants. *Insects*, 2012; 3(1): 41-61.

#### *Genome announcements (editorial review only)*

1. **FO Aylward**, DM Tremmel<sup>#</sup>, GJ Starrett<sup>#</sup>, DC Bruce, P Chain, A Chen, KW Davenport, C Detter, CS Han, J Han, M Huntemann, NN Ivanova, NC Kyrpides, V Markowitz, K Mavrommatis, M Nolan, I Pagani, A Pati, S Pitluck, C-L Wei, LA Goodwin, T Woyke, CR Currie. Complete Genome of *Serratia* sp. Strain FGI 57, a Strain Associated with Leaf-cutter Ant Fungus Gardens. *Genome Announcements*, 2013; 1(2): e00239-12.
2. **FO Aylward**, DM Tremmel<sup>#</sup>, DC Bruce, P Chain, A Chen, KW Davenport, C Detter, CS Han, J Han, M Huntemann, NN Ivanova, NC Kyrpides, V Markowitz, K Mavrommatis, M Nolan, I Pagani, A Pati, S Pitluck, C-L Wei, LA Goodwin, T Woyke, CR Currie. Complete Genome of *Enterobacteriaceae* Bacterium Strain FGI 57, a Strain Associated with Leaf-cutter Ant Fungus Gardens. *Genome Announcements*, 2013; 1(1): e00238-12.

#### *Book chapters*

1. G Suen, JJ Scott, **FO Aylward**, CR Currie. The Microbiome of Leaf-cutter Ant Fungus Gardens. In: de Bruin, F.J. ed., *Handbook of Molecular Microbial Ecology, Volume 2: Metagenomics in Different Habitats*, 2011, pp. 367-380. John Wiley and Sons, Inc., Hoboken, NJ, USA.
2. G Suen, **FO Aylward**, SC Slater, BS Goldman. From Genetics to Genomics. In: Maloy, S., Hughes, K.T., Casadesus, J. eds., *The Lure of Bacterial Genetics: A Tribute to John Roth*, 2010, pp. 257-266. American Society for Microbiology Press, Washington, D.C., USA.

#### *Articles with undergraduate students (published in non-refereed undergraduate research compilations)*

1. DP Declat<sup>#</sup>, **FO Aylward**, CR Currie. Interactions Between Actinobacteria and Other Microorganisms Present in the Fungus Gardens of Leaf-cutter Ants. Integrated Biological Sciences Summer Research Program (IBS-SRP) Research Journal, 2010
2. JA Montalvo<sup>#</sup>, **FO Aylward**, G Suen, A Valenzuela, CR Currie. Characterizing Lignocellulose-Degrading Microbes from the Fungus Gardens of Leaf-Cutting Ants. Integrated Biological Sciences Summer Research Program (IBS-SRP) Research Journal, 2009.

## SERVICE

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### *Ad Hoc Academic Reviewing*

**Journals:** *Applied and Environmental Microbiology* [1], *Applied Microbiology and Biotechnology* [1], *Bioinformatics* [1], *BMC Genomics* [4], *Diversity* [1], *Ecological Entomology* [2], *Environmental Microbiology* [6], *Frontiers in Microbiology* [25], *Genome Biology and Evolution* [1], *Gut Microbes* [1], *The ISME Journal* [5], *Journal of Agricultural and Food Chemistry* [1], *Journal of Genetic Engineering and Biotechnology* [1], *mBio* [1], *Microbial Ecology* [3], *Microbiome* [1], *Microorganisms* [1], *Molecular Ecology* [2], *mSystems* [1], *Nature Communications* [2], *Nature Methods* [1], *PLOS Computational Biology* [1], *PLOS ONE* [1], *Proceedings of the National Academy of Sciences USA* [1], *Science Bulletin* [1], *Scientific Reports* [1], *Water Science and Technology* [1].

### *Editorial Service*

**Review Editor:** *Frontiers in Microbiology & Frontiers in Marine Science* (2015-).

**Editorial Board Member:** *Environmental Microbiology & Environmental Microbiology Reports* (2018-)

### *Conference Organization*

**Graduate Student Coordinator:** Great Lakes Bioenergy Research Center annual retreat planning committee (May 2011).

## PRESENTATIONS

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November 4 <sup>th</sup> , 2019	Department of Microbiology seminar series, University of Tennessee at Knoxville
October 2 <sup>nd</sup> , 2019	Department of Biological Sciences seminar series, University of North Carolina-Greensboro
September 24 <sup>th</sup> , 2019	Department of Biological Sciences seminar series, University of Virginia.
July 18 <sup>th</sup> , 2018	Computer and Information Sciences Research Colloquium, Virginia Military Academy.
November 28 <sup>th</sup> , 2017	Microbiology Seminar series, Virginia Tech.
November 13 <sup>th</sup> , 2017	Biochemistry Department seminar series, Virginia Tech.
March 3 <sup>rd</sup> , 2017	American Society for Limnology and Oceanography (ASLO), Honolulu, HI.
December 1 <sup>st</sup> , 2016	Department of Biological Sciences, Virginia Tech.
September 12 <sup>th</sup> , 2016	Agricultural and Biosystems Engineering, University of Arizona.
June 18 <sup>th</sup> , 2016	ASM Microbe, Boston, MA.
April 20 <sup>th</sup> , 2016	Ecosystem Genomics Initiative, University of Arizona.
April 6 <sup>th</sup> , 2016	Molecular, Cellular, and Biomedical Sciences, University of New Hampshire.
March 3 <sup>rd</sup> , 2016	Department of Oceanography, University of Hawaii at Manoa.
February 9 <sup>th</sup> , 2016	Biology Department, Utah State University.
January 12 <sup>th</sup> , 2016	Marine, Earth, and Atmospheric Sciences, NC State University.
August 19 <sup>th</sup> , 2012	International Society for Microbial Ecology meeting, Copenhagen, Denmark.
May 17 <sup>th</sup> , 2011	Great Lakes Bioenergy Research Center annual retreat, South Bend, IN.

## TEACHING

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### *University Courses Taught at Virginia Tech*

*As primary instructor*

Systems Biology 2025, Introduction to Systems Biology I	Fall 2017
Systems Biology 3035, Systems Biology of Genes and Proteins I	Fall 2019
Systems Biology 3036, Systems Biology of Genes and Proteins II	Spring 2018, 2019, 2020

### *As co-instructor*

Microbial Community Analysis GRAD6895, Analysis of Microbiome Data	Spring 2019
Systems Biology 2025, Introduction to Systems Biology I	Fall 2018, 2019
Systems Biology 2026, Introduction to Systems Biology II	Spring 2019, 2020

### **Workshops**

2016	<i>Instructor</i> , Oceanography and Geobiology Environmental 'Omics workshop sponsored by the NSF-funded EarthCube program. Topic: Introduction to metagenome assembly and analysis. Hosted by the University of Hawaii at Manoa.
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### **Guest lectures**

2018	Population Genomics, FREC 5164. Topic: Microbial Genomics.
2017	Quantitative Ecology, BIOL 6004. Topic: Microbial Ecology.
2016	Oceanography 750. Topic: Marine Microbiology. UH Manoa.
2011	Microbiology 551. Topic: Ecological genomics. UW-Madison.
2010	Agronomy 375. Topic: Microbial genomics. UW-Madison.

### **Teaching Assistantships**

2010-11, '13	<i>Teaching Assistant</i> . Microbiology 450, UW-Madison
2009	<i>Teaching Assistant</i> . Microbiology 301 Laboratory, UW-Madison

## **OUTREACH & MENTORSHIP**

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### **Mentorship**

2018-	Thesis advisor to students Carolina Martinez and Alaina Weinheimer, both PhD students in the Virginia Tech Biological Sciences Graduate Program.
2018-	Thesis advisor to Nitin Nair, student in the Electrical and Computer Engineering MS program at Virginia Tech.
2018-	Research advisor to Meagan Todd, Gavin Mucker, and Ashleen Harris, undergraduate students in the Systems Biology undergraduate program at Virginia Tech.
2010-2013	Mentor to two undergraduate Microbiology majors, Daniel Tremmel and Gabriel Starrett, who have subsequently appeared as co-authors on peer-reviewed journal articles ( <i>see Publications section</i> ). Both students are currently in PhD programs.
2010	Mentor for Thiruvenkadam Shanmugam, a participant in the Khorana Program for Scholars, hosted by UW-Madison and New Delhi University. Thiru is currently in a PhD program at Myongji University in the Republic of South Korea.
2009, 2010	Mentor for David Pagan-Declet and Jorge Montalvo ('09 and '10, respectively), students in the Integrated Biological Science Summer Research Program (IBS-SRP), Great Lakes Bioenergy Research Center. Both students were undergraduates at the University of Puerto Rico and subsequently published their work in undergraduate research journals ( <i>see Publications section</i> ).
2009	Mentor to Rhonda Knapp, a participant in the Research Experience for Teachers Program hosted by the Great Lakes Bioenergy Research Center. This program provided research experience to

elementary school teachers in the greater Madison area. I assisted in developing a bioenergy-related research project and the design of curricula for middle-school science classes.

2009 Mentor to Microbiology undergraduate Austin Lynch on a two-semester project integrating computational and wet-lab methods.

2007, 2008 Peer Mentors Program, Department of Biochemistry, University of Arizona, Tucson, Arizona. In this program I mentored freshmen Biochemistry majors for one year.

### Outreach

2018 Guest speaker at the Blacksburg High School College Research event, where I gave several presentations on the Systems Biology program at Virginia Tech.

2017- I have posted > 30 open-access bioinformatics tutorials on the Protocols.IO website in an effort to make these teaching materials more broadly available.

Link: <https://www.protocols.io/researchers/frank-aylward>

2010 Speaker at the Monona Grove Energy Fair, held on May 22. This was a program supported by the Wisconsin Bioenergy Institute intended to broaden public knowledge of bioenergy research.

2010 Speaker for the UW-Madison People Program. This program exposes high school students to research in university labs.

2010 Speaker for the UW-Madison, Department of Bacteriology undergraduate Microbiology Club.

2010 Speaker in the Biological Sciences Preview Weekend at UW-Madison, held from October 21st-24th. The purpose of this program was to allow under-represented minorities in college to explore research opportunities at UW-Madison.

2006-2008 Ambassadors program, Department of Biochemistry, University of Arizona, Tucson, Arizona. In this program I participated in outreach activities spreading awareness of scientific careers and opportunities to high school students.