

BRIAN H. CLOWERS PH.D.

Analytical Chemist

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EDUCATION

DOCTOR OF PHILOSOPHY, CHEMISTRY 2005

Washington State University, Pullman, WA
Field of Specialty: Analytical Chemistry
Dissertation Title: Separation of Gas Phase Isomers Using Ion Mobility and Mass Spectrometry

BACHELORS OF SCIENCE, CHEMISTRY (ACS CERTIFIED) 2000

University of Nevada, Reno, NV
Thesis Title: Characterization of Diesel Particulate Exposure Levels Experienced by Underground Mine Workers

EXPERIENCE

RESEARCH SCIENTIST 2008-PRESENT
Chemical and Biological Sciences
National Security Directorate
Pacific Northwest National Laboratory

POST-DOCTORAL RESEARCH FELLOW 2006-2008
Biological Separations and Mass Spectrometry
Fundamental Science Directorate,
Pacific Northwest National Laboratory
(Dr. Richard D. Smith)

POST-DOCTORAL RESEARCH FELLOW 2005-2006
Department of Chemistry
University of California, Davis
(Dr. Carlito B. Lebrilla & Dr. Jerry L. Hedrick)

GRADUATE RESEARCH ASSISTANT 2000-2005
Department of Chemistry
Washington State University, Pullman, WA
(Professor Herbert H. Hill Jr.)

RESEARCH ASSISTANT 2002-2004
Laboratory for Biotechnology and Bioanalysis
WSU Mass Spectrometry Core Facility, Pullman, WA
(Dr. William F. Siems)

PUBLICATIONS

Across 37 publications a total of 696 citations (525 unique) and a h-index of 15 as of September 15, 2012.

37. Davis, E.J., B.H. Clowers, W.F. Siems, H.H. Hill. Comprehensive software suite for the operation, maintenance, and evaluation of an ion mobility spectrometer. *International Journal for Ion Mobility Spectrometry*. 2011, 14(2-3), 117-124.
36. Froehlich, J.W., M. Barboza, C. Chu, L.A. Lerno, B.H. Clowers, A.M. Zivkovic, J.B. German, and C.B. Lebrilla. Nano-LC-MS/MS of Glycopeptides Produced by Nonspecific Proteolysis Enables Rapid and Extensive Site-Specific Glycosylation Determination. *Analytical Chemistry*, 2011. 83(14): p. 5541-5547.
35. Shah, A.R., J. Davidson, M.E. Monroe, A.M. Mayampurath, W.F. Danielson, Y. Shi, A.C. Robinson, B.H. Clowers, M.E. Belov, G.A. Anderson, and R.D. Smith. An Efficient Data Format for Mass Spectrometry-Based Proteomics. *Journal of the American Society for Mass Spectrometry*, 2010. 21(10): p. 1784-1788.
34. Fraga, C.G., B.H. Clowers, R.J. Moore, and E.M. Zink. Signature-Discovery Approach for Sample Matching of a Nerve-Agent Precursor Using Liquid Chromatography-Mass Spectrometry, XCMS, and Chemometrics. *Analytical Chemistry*, 2010. 82(10): p. 4165-4173.
33. Zhu, M.L., B. Bendiak, B.H. Clowers, and H.H. Hill. Ion mobility-mass spectrometry analysis of isomeric carbohydrate precursor ions. *Analytical and Bioanalytical Chemistry*, 2009. 394(7): p. 1853-1867.
32. Tolmachev, A.V., B.H. Clowers, M.E. Belov, and R.D. Smith. Coulombic Effects in Ion Mobility Spectrometry. *Analytical Chemistry*, 2009. 81(12): p. 4778-4787.
31. Johnson, T.J., Y.F. Su, N.B. Valentine, H.W. Kreuzer-Martin, K.L. Wahl, S.D. Williams, B.H. Clowers, and D.S. Wunschel. The Infrared Spectra of Bacillus Bacteria Part I: Vegetative Bacillus versus Sporulated Cells and the Contributions of Phospholipids to Vegetative Infrared Spectra. *Applied Spectroscopy*, 2009. 63(8): p. 899-907.
30. Dodds, E.D., R.R. Seipert, B.H. Clowers, J.B. German, and C.B. Lebrilla. Analytical Performance of Immobilized Pronase for Glycopeptide Footprinting and Implications for Surpassing Reductionist Glycoproteomics. *Journal of Proteome Research*, 2009. 8(2): p. 502-512.
29. Chu, C.S., M.R. Ninonuevo, B.H. Clowers, P.D. Perkins, H.J. An, H.F. Yin, K. Killeen, S. Miyamoto, R. Grimm, and C.B. Lebrilla. Profile of native N-linked glycan structures from human serum using high performance liquid chromatography on a microfluidic chip and time-of-flight mass spectrometry. *Proteomics*, 2009. 9(7): p. 1939-1951.
28. Beagley, N., C. Scherrer, Y. Shi, B.H. Clowers, W.F. Danielson, and A.R. Shah. Increasing the Efficiency of Data Storage and Analysis Using Indexed Compression. *Fifth IEEE International Conference on e-Science*. p. 66-71.

27. Seipert, R.R., E.D. Dodds, B.H. Clowers, S.M. Beecroft, J.B. German, and C.B. Lebrilla. Factors that influence fragmentation behavior of N-linked glycopeptide ions. *Analytical Chemistry*, 2008. 80(10): p. 3684-3692.
26. Lopez-Ferrer, D., K. Petritis, N.M. Lourette, B.H. Clowers, K.K. Hixson, T. Heibeck, D.C. Prior, L. Pasa-Tolic, D.G. Camp, M.E. Belov, and R.D. Smith. On-line Digestion System for Protein Characterization and Proteome Analysis. *Analytical Chemistry*, 2008. 80(23): p. 8930-8936.
25. Dodds, E.D., B.H. Clowers, P.J. Hagerman, and C.B. Lebrilla. Systematic characterization of high mass accuracy influence on false discovery and probability scoring in peptide mass fingerprinting. *Analytical Biochemistry*, 2008. 372(2): p. 156-166.
24. Clowers, B.H., Y.M. Ibrahim, D.C. Prior, W.F. Danielson, M.E. Belov, and R.D. Smith. Enhanced ion utilization efficiency using an electrodynamic ion funnel trap as an injection mechanism for ion mobility spectrometry. *Analytical Chemistry*, 2008. 80(3): p. 612-623.
23. Clowers, B.H., E.D. Dodds, R.R. Seipert, and C.B. Lebrilla. Dual polarity accurate mass calibration for electrospray ionization and matrix-assisted laser desorption/ionization mass spectrometry using maltooligosaccharides. *Analytical Biochemistry*, 2008. 381(2): p. 205-213.
22. Clowers, B.H., M.E. Belov, D.C. Prior, F.D. William, Y. Ibrahim, and R.D. Smith. Pseudorandom sequence modifications for ion mobility orthogonal time-of-flight mass spectrometry. *Analytical Chemistry*, 2008. 80(7): p. 2464-2473.
21. Belov, M.E., B.H. Clowers, D.C. Prior, W.F. Danielson, A.V. Liyu, B.O. Petritis, and R.D. Smith. Dynamically multiplexed ion mobility time-of-flight mass spectrometry. *Analytical Chemistry*, 2008. 80(15): p. 5873-5883.
20. Kirmiz, C., B. Li, H.J. An, B.H. Clowers, H.K. Chew, K.S. Lam, A. Ferrige, R. Alecio, A.D. Borowsky, S. Sulaimon, C.B. Lebrilla, and S. Miyamoto. A serum glycomics approach to breast cancer biomarkers. *Molecular & Cellular Proteomics*, 2007. 6(1): p. 43-55.
19. Dwivedi, P., B. Bendiak, B.H. Clowers, and H.H. Hill. Rapid resolution of carbohydrate isomers by electrospray ionization ambient pressure ion mobility spectrometry-time-of-flight mass spectrometry (ESI-APIMS-TOFMS). *Journal of the American Society for Mass Spectrometry*, 2007. 18(7): p. 1163-1175.
18. Clowers, B.H., E.D. Dodds, R.R. Seipert, and C.B. Lebrilla. Site determination of protein glycosylation based on digestion with immobilized nonspecific proteases and Fourier transform ion cyclotron resonance mass spectrometry. *Journal of Proteome Research*, 2007. 6: p. 4032- 4040.
17. Chavarra-Miranda, D., B.H. Clowers, G. Anderson, and M. Belov. Simulating data processing for an advanced ion mobility mass spectrometer, *Proceedings of the 1st International Workshop on High-performance Reconfigurable Computing Technology and Applications*, ACM: Reno, Nevada. p. 21-29.

16. Baker, E.S., B.H. Clowers, F.M. Li, K. Tang, A.V. Tolmachev, D.C. Prior, M.E. Belov, and R.D. Smith. Ion mobility spectrometry-mass spectrometry performance using electrodynamic ion funnels and elevated drift gas pressures. *Journal of the American Society for Mass Spectrometry*, 2007. 18(7): p. 1176-1187.
15. Ninonuevo, M.R., Y. Park, H.F. Yin, J.H. Zhang, R.E. Ward, B.H. Clowers, J.B. German, S.L. Freeman, K. Killeen, R. Grimm, and C.B. Lebrilla. A strategy for annotating the human milk glycome. *Journal of Agricultural and Food Chemistry*, 2006. 54(20): p. 7471-7480.
14. Dwivedi, P., C. Wu, L.M. Matz, B.H. Clowers, W.F. Siems, and H.H. Hill. Gas-phase chiral separations by ion mobility spectrometry. *Analytical Chemistry*, 2006. 78(24): p. 8200-8206.
13. Clowers, B.H., W.F. Siems, H.H. Hill. and S.M. Massick. Hadamard transform ion mobility spectrometry. *Analytical Chemistry*, 2006. 78(1): p. 44-51.
12. Clowers, B.H. and H.H. Hill. Influence of cation adduction on the separation characteristics of flavonoid diglycoside isomers using dual gate-ion mobility-quadrupole ion trap mass spectrometry. *Journal of Mass Spectrometry*, 2006. 41(3): p. 339-351.
11. Steiner, W.E., S.J. Klopsch, W.A. English, B.H. Clowers, and H.H. Hill. Detection of a chemical warfare agent simulant in various aerosol matrixes by ion mobility time-of-flight mass spectrometry. *Analytical Chemistry*, 2005. 77(15): p. 4792-4799.
10. Clowers, B.H. and H.H. Hill. Mass analysis of mobility-selected ion populations using dual gate, ion mobility, quadrupole ion trap mass spectrometry. *Analytical Chemistry*, 2005. 77(18): p. 5877-5885.
9. Clowers, B.H., P. Dwivedi, W.E. Steiner, H.H. Hill. and B. Bendiak. Separation of sodiated isobaric disaccharides and trisaccharides using electrospray ionization-atmospheric pressure ion mobility- time of flight mass spectrometry. *Journal of the American Society for Mass Spectrometry*, 2005. 16(5): p. 660-669.
8. Steiner, W.E., B.H. Clowers, W.A. English, and H.H. Hill. Atmospheric pressure matrix-assisted laser desorption/ionization with analysis by ion mobility time-of-flight mass spectrometry. *Rapid Communications in Mass Spectrometry*, 2004. 18(8): p. 882-888.
7. Steiner, W.E., B.H. Clowers, and H.H. Hill. Rapid separation of phenylthiohydantoin amino acids: ambient pressure ion-mobility mass spectrometry (IMMS). *Analytical and Bioanalytical Chemistry*, 2003. 375(1): p. 99-102.
6. Steiner, W.E., B.H. Clowers, P.E. Haigh, and H.H. Hill. Secondary ionization of chemical warfare agent simulants: Atmospheric pressure ion mobility time-of-flight mass spectrometry. *Analytical Chemistry*, 2003. 75(22): p. 6068-6076.
5. Steiner, W.E., B.H. Clowers, L.M. Matz, W.F. Siems, and H.H. Hill. Rapid screening of aqueous chemical warfare agent degradation products: Ambient pressure ion mobility mass spectrometry. *Analytical Chemistry*, 2002. 74(17): p. 4343-4352.

4. Matz, L.M., W.E. Steiner, B.H. Clowers, and H.H. Hill. Evaluation of micro-electrospray ionization with ion mobility spectrometry/mass spectrometry. *International Journal of Mass Spectrometry*, 2002. 213(2-3): p. 191-202.
3. Steiner, W.E., B.H. Clowers, K. Fuhrer, M. Gonin, L.M. Matz, W.F. Siems, A.J. Schultz, and H.H. Hill. Electrospray ionization with ambient pressure ion mobility separation and mass analysis by orthogonal time-of-flight mass spectrometry. *Rapid Communications in Mass Spectrometry*, 2001. 15(23): p. 2221-2226.
2. Matz, L.M., B.H. Clowers, W.E. Steiner, W.F. Siems, and H.H. Hill, Liquid-sheath-flow electrospray ionization feasibility study of direct water analysis with the use of high-resolution ion-mobility spectrometry. *Field Analytical Chemistry and Technology*, 2001. 5(1-2): p. 91-96.
1. Clowers, B.H., W.E. Steiner, H.M. Dion, L.M. Matz, M. Tam, E.E. Tarver, and H.H. Hill, Evaluation of sulfonyleurea herbicides using high resolution electrospray ionization ion mobility quadrupole mass spectrometry. *Field Analytical Chemistry and Technology*, 2001. 5(6): p. 302-312.

MANUSCRIPTS IN PREPARATION

1. Brian H. Clowers, David S. Wunschel, Helen Kreuzer, Heather Engelmann, Nancy Valentine, Karen Wahl. Characterization of Residual Medium Peptides from *Yersinia pestis* Cultures. Submitted to *Analytical Chemistry* (October 2012).
2. Robert Ewing, David A. Atkinson, Brian H. Clowers. Direct Real-Time Detection of RDX Vapors Under Ambient Conditions. Submitted to *Analytical Chemistry* (September 2012).
3. Brian H. Clowers, Aaron C. Robinson, Janine Hutchison, Heather Engelmann, Helen Kreuzer. Impact of Inactivation Condition on Observed Protein Content. In preparation for submission to *Applied and Environmental Microbiology*.

BOOK CHAPTERS

1. Wahl, Karen L., Wunschel, David S. and Clowers, Brian H. 2010. "Proteomics Development and Application for Bioforensics." Chapter 26 in *Microbial Forensics*, 2nd Edition, ed. B Budowle, SE Schutzer, RG Breeze, PS Keim and SA Morse, pp. 449-460. Academic Press/Elsevier, Burlington, MA.

PATENTS

1. System and process for selective detection of vapor-phase analytes. US Pat. Submitted, March 2012
2. Ion funnel ion trap and process. US Pat. 12156360, 2010
3. Mass analysis of mobility selected ion populations US Pat. 11582198, 2007

PRESENTATIONS

Since 2005 over 45 scientific presentations have been given in both oral and poster formats at a range of national and international conference venues. Recent presentations include:

1. Media Derived Protein Profiles of Microbial Samples, Brian H. Clowers, David Wunschel, Nancy B. Valentine, Heather Engelmann, Karen Wahl. White House Interagency Microbial Forensics Advisory Board, Non-Genomic Forensic Signatures, July 12, 2012, Springfield, VA. (Invited Oral Presentation)
2. Forensic Characterization of Microbial Growth Conditions using Emergent Peptide Signatures. Brian H. Clowers, Helen Kreuzer, David S. Wunschel, Heather Engelmann, Nancy B. Valentine, Karen L. Wahl. 5th National Biothreat Conference, 2012, Denver, CO. (Poster Presentation)
3. Forensic Identification of Growth Conditions Using Residual Medium Peptides. Brian H. Clowers, Helen Kreuzer, David S. Wunschel, Heather Engelmann, Nancy B. Valentine, Karen L. Wahl. DTRA Chemical and Biological Science and Technology Conference, 2011, Las Vegas, NV. (Invited Oral Presentation)
4. Analysis of Proteins and Metabolites of Unknown Samples to Complement Genetic Characterizations. Karen Wahl, Nancy Valentine, Brian Clowers, David Wunschel, Christopher Ehrhardt, Heather Engelmann, Angela Melville, Kathryn Antolick, Jon Wahl, Janine Hutchison, Christina Sorensen. DHT Science and Technology Biological Forensics Review, 2011, Alexandria, VA. (Oral Presentation)
5. Characterization of Urea and Ammonium Nitrate by Ion Mobility-Mass Spectrometry. Brian H. Clowers, Robert G. Ewing, David A. Atkinson, Melanie J. Waltman. Trace Explosives Detection Conference, 2011, Portland, OR. (Oral Presentation)

AWARDS AND RECOGNITION

PNNL National Security Directorate LDRD (FY 2011-2012) -"Statistically Significant Forensic Fingerprinting: Protein Analysis of Biological Agents."

PNNL Outstanding Performance Award (FY 2009)

NSD PNNL Explosive Initiative LDRD (FY 2009-2010)-"Enhanced Detection Mechanisms for Ion Mobility Spectrometry."

PNNL Data Intensive Computing Initiative LDRD (FY 2008)-"Intelligent Compression and Data Organization for Multidimensional Data Volumes."

Post-Doctoral Fellowship (2005-2006)—NICHD Fertilization and Early Development Training Grant

NSF Fellowship (2001-2005)—NSF IGERT Program

Sierra Pacific Foundation Scholarship (1997-2000)

AREAS OF PROFICIENCY

Mass Spectrometry: Linear, Triple, and Ion Trap Quadrupole MS, Fourier Transform-MS, and Time-of-Flight Mass Spectrometry. Ionization Techniques: Electrospray Ionization, Laser Desorption, and Radioactive Sources

Chromatography: Ion Mobility Spectrometry; High Performance Liquid Chromatography; nano-Liquid Chromatography; Gas Chromatography; and Ion-Exchange Chromatography

Computers and Software: Hardware, software, and network configuration of Linux and Windows workstations.

Technical Computing Experience: MATLAB, SIMION, SolidWorks.

Programming Languages: Python, C++, IGOR Pro, R, and LabVIEW.

Additional Analytical Techniques: Fourier Transform-IR, ¹H and ¹³C-NMR, Atomic Absorption-Atomic Emission, and Liquid Scintillation Counting

PROFESSIONAL AFFILIATIONS

American Society for Mass Spectrometry

International Society for Ion Mobility Spectrometry

Phi Lambda Upsilon: Honorary Chemical Society

American Chemical Society

-Analytical Chemistry Division

Continuing Professional Service:

-Peer reviewer for Analytical Chemistry, Journal of the American Society for Mass Spectrometry, and the International Journal of Ion Mobility Spectrometry.