

## CRAIG ARTHUR TOWNSEND

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Date of Birth 19 August 1947 (Chicago, Illinois)

Marital Status: Married, 2 Children

### Professional Experience

1969 B. A. *cum laude*, with Honors in Chemistry, Williams College,  
Williamstown, Massachusetts

1974 Ph.D., Organic Chemistry, Yale University, New Haven, Connecticut;  
Professor A. Ian Scott, Thesis Advisor

1974–1976 Postdoctoral Fellow, Eidgenössische Technische Hochschule, Zürich,  
Switzerland; Professor Duilio Arigoni, Advisor

1976–1982 Assistant Professor of Chemistry, The Johns Hopkins University, Baltimore,  
Maryland

1982–1985 Associate Professor of Chemistry, The Johns Hopkins University

1984–Present Joint Appointment Department of Biology and The McCollum-Pratt  
Institute, The Johns Hopkins University

1985–Present Professor of Chemistry, The Johns Hopkins University

1987 Visiting Professor of Chemistry, Harvard University, Cambridge,  
Massachusetts

1989-Present Joint Appointment Thomas C. Jenkins Department of Biophysics, The Johns  
Hopkins University

1990-1994 Chairman, Department of Chemistry, The Johns Hopkins University

1997-Present Alsoph H. Corwin Professor of Chemistry

### Honors

Predocctoral Fellowship, NIH (Yale, 1970–1973); Richard L. Wolfgang Prize (Yale, 1973); International Exchange Postdoctoral Fellow, Swiss National Science Foundation (E.T.H., 1974–1976); Research Fellow of The Alfred P. Sloan Foundation (1982–1986); Camille and Henry Dreyfus Teacher-Scholar (1983–1988); Stuart Pharmaceuticals Award in Chemistry (1986); Distinguished Lecturer, University of Hawaii (1988); Robert A. Welch Foundation Lectureship (1989); H. Martin Friedman Lecture, Rutgers (1990); Boehringer-Ingelheim Lecture, Yale (1992); Maryland Chemist of the Year, Maryland Section of the ACS (1992); Arthur C. Cope Scholar Award, ACS (1995); Gomberg Lecture, University of Michigan (1997); Pfizer Distinguished Lecturer, Colorado State University (1999); University of Michigan/Pfizer Symposium (2002); University of California, Irvine/Pfizer Symposium (2003); MERIT Award, NIH (2004-2014); Fellow of the AAAS (2003); Hutchinson Lecture, Wisconsin (2011); Royal Society of Chemistry Bioorganic Chemistry Group Lecture, Nottingham, England (2012); A. I. Scott Medal for Excellence in Biological Chemistry Research, ACS (2013).

### Service

N.I.H. Special Study Sections (1980–Present); *Ad hoc* member Bioorganic and Natural Products Study Section (June, 1984); Regular member Bioorganic and Natural Products Study Section (1985–1989); American Chemical Society Canvassing Committee for the Ernest Guenther Award (1985–1988, Chairman 1988); Organic Program Chairman, Middle Atlantic Regional ACS Meeting (1986); Editorial Advisory Board of *The Journal of Organic Chemistry* (1987–1991); Symposium Co-organizer, 1989 International Chemical Congress of Pacific Basin Societies (1989); Co-Chairman, NSF Workshop on Organic Synthesis and Natural Products (1989-1992); Alternate Councilor, Division of Biological Chemistry, ACS (1991-1994); Co-organizer and cofounder Bioorganic Chemistry Gordon Research Conference (1992); Advisory Panel, Office of Technology Assessment (1994-1995); Symposium Co-organizer, 1995 International Chemical Congress of Pacific Basin Societies (1995), Editorial Board of *Bioorganic Chemistry* (1998-); Symposium Co-organizer, 2000 International Chemical Congress of Pacific Basin Societies (2000); Nominating Committee, Division of Biological Chemistry, ACS (1998-1999); Alternate Councilor, Division of Biological Chemistry, ACS (1999-2001); Council of the Gordon Research Conferences, at-large member (2001-); Editorial Board of *Chemistry & Biology* (2002-), Symposium Co-organizer, 2005 International Chemical Congress of Pacific Basin Societies (2005). Advisory Board, NIH Program Project Grant "Discovery, Design, and Development of Phosphonic Acid Antibiotics," University of Illinois (2008-), Symposium Co-organizer, 2010 International Chemical Congress of Pacific Basin Societies (2010); Chairman-Elect, Biological Division, ACS (2015-2016).

### Principal Invited Lectures (last 20 years)

1990: Martin H. Friedman Lecture, Rutgers \*\* 21st Annual Workshop in Organic Synthesis and Natural Products Chemistry (Sponsor: NSF), Pingree Park, CO \*\* Natural Products Gordon Research Conference, New Hampton, NH. 1991: Division of Agricultural and Food Chemistry Symposium: "Biosynthesis and Metabolism of Secondary-Metabolite Natural Products," National ACS Meeting, Atlanta, GA \*\* Divisions of Organic and Biological Chemistry "Symposium on Biosynthesis in Honour of I. D. Spenser," Canadian Chemical Conference and Exhibition, Hamilton, Ontario \*\* 22nd Annual Workshop in Organic Synthesis and Natural Products Chemistry (Sponsor: NSF), Minary Center, Squam Lake, NH \*\* Division of Organic Chemistry, Plenary Lecture, 4th Chemical Congress of North America, New York,

NY. \*\* Division of Organic Chemistry Symposium: "Catalysis of (Carbon–Carbon) Bond Formation," Southeast Regional ACS Meeting, Richmond, VA, 1992; Boehringer-Ingelheim Lecture, Yale University, New Haven, CT \*\* Division of Biochemical Technology "Symposium on Non-Template Derived Polymeric Natural Products: Assembly and Tailoring," National ACS Meeting, San Francisco, CA \*\* 23rd Annual Workshop in Organic Synthesis and Natural Products Chemistry (Sponsor: NSF), Highland Lake Inn and Conference Center, NC \*\* The Royal Society of Chemistry and the Phytochemistry Society, Symposium in honour of A. R. Battersby: "Perspectives and Prospects in Bioorganic Chemistry," Cambridge, England \*\* The Royal Society, 3rd Firth Conference, Perthshire, Scotland \*\* The Biochemical Society, Meeting 644, "The Genetics and Enzymology of Multienzyme Systems," Glasgow, Scotland. 1993: Bioorganic Chemistry Gordon Research Conference, Andover, NH \*\* Division of Organic Chemistry Symposium: "New Horizons in Natural Product Chemistry," National ACS Meeting, Chicago, IL \*\* 15th International Botanical Congress, Yokohama, Japan \*\* Toyobo Biotechnology Foundation Symposium: "Recent Progress in the Biosynthesis of Natural Products," Tokyo, Japan. 1994: 28th European Symposium on Bio-Organic Chemistry (ESBOC), Gregynog, Wales \*\* US-Japan Seminar on the Biosynthesis of Natural Products (U. S. sponsor: NSF), Susono City, Japan \*\* Enzymes, Coenzymes and Metabolic Pathways Gordon Research Conference, Meriden, NH. 1995: 1995 Lecturer in Pharmaceutical Chemistry, University of Wisconsin, Madison, WI \*\* Division of Organic Chemistry: Arthur C. Cope Award Symposium, National ACS Meeting, Chicago, IL. 1996: Symposium zu Ehren von Professor Duilio Arigoni: "Perspectives in Bioorganic Chemistry," ETH, Zürich, Switzerland \*\* "Enseignement du Troisième Cycle," lecture series at the Universities of Basle, Bern, Neuchatel and Lausanne \*\* Annual Meeting Society of Industrial Microbiology, Symposium: "Advances in  $\beta$ -Lactam Production," Research Triangle Park, NC. 1997: 5th US-Japan Seminar on Biosynthesis of Natural Products, Winthrop, WA \*\* 38th Annual Meeting American Society of Pharmacognosy, Iowa City, IA \*\* Gomberg Lecture, University of Michigan, Ann Arbor, MI. 1998: Chemistry Reunion and Symposium to honor Professor J. Hodge Markgraf, Williams College, Williamstown, MA \*\* 98th General Meeting American Society of Microbiology, Symposium: "Evolution and Metabolic Engineering of Biosynthetic Pathways," Atlanta, GA \*\* 8th International Symposium Genetics of Industrial Microorganisms, Symposium: "Structure-Function Studies of Biosynthetic Enzymes in Secondary Metabolism," Jerusalem, Israel \*\* Royal Society of Chemistry, "Polyketides II," Bristol, UK. 1999: Bioorganic Chemistry Gordon Research Conference, Andover, NH \*\* Northwest Regional ACS Meeting, Portland, OR. 2000: Enzymes, Coenzymes and Metabolic Pathways Gordon Research Conference, Meriden, NH \*\* 6<sup>th</sup> Biennial Symposium "Frontiers in Organic Chemistry," University of Illinois, Urbana, IL \*\* International Chemical Congress of Pacific Basin Societies (Pacifichem), "Symposium on Antibiotics," Honolulu, HI. 2001: Volcano Conference in Bioorganic Chemistry, Pack Forest, WA \*\* US-Japan Seminar on Biosynthesis of Natural Products, Girdwood, AK \*\* Royal Society of Chemistry, "Polyketides III," Bristol, UK. 2002: University of Michigan/Pfizer Symposium: "Challenges in Organic Chemistry," Ann Arbor, MI \*\* American Society of Microbiology, Symposium: "Exploring Secondary Metabolism Using Emerging Technologies," Salt Lake City, UT. 2003: American Society of Biochemistry and Molecular Biology, Symposium: "Complex Biological Oxidations," San Diego, CA \*\* Heterocyclic Compounds Gordon Research Conference, Newport, RI \*\* University of California, Irvine/Pfizer Symposium: "Biosynthetic Pathways and Small Molecule Synthesis," Irvine, CA. 2004: Texas A & M University Symposium in honor A. Ian Scott: "Recent Advances in Bioorganic Chemistry," College Station, TX \*\* Division of Organic Chemistry/GlaxoSmithKline Symposium: "Frontiers in Chemistry and Medicine Symposium II," Southeast Regional ACS Meeting, Research Triangle Park, NC. 2005: "Peter Yates Memorial Lecture," University of Toronto, Toronto, Canada \*\* Bioorganic Chemistry Gordon Research Conference, Andover, NH \*\* American Society of Pharmacognosy, "Contemporary Approaches in Natural Product Biosynthesis," Corvallis, OR. 2006: 40<sup>th</sup> European Symposium on Bioorganic Chemistry (ESBOC), "Natural Products and their Cellular Targets," Gregynog, Wales \*\* Trends in Enzymology, "Enzymes of Secondary Metabolism," Como, Italy \*\* Society for Industrial Microbiology, "Fungal Proteomics in

Agriculture” & “Novel Enzymology for Natural Product Biosynthesis and Engineering,” Baltimore, MD \*\* Royal Society Symposium , Chemical Biology “Directing Biosynthesis,” Cambridge, England. 2007: 15<sup>th</sup> International Conference on Cytochromes P450, Bled, Slovenia (declined) \*\* Enzymes, Coenzyme & Metabolic Processes Gordon Research Conference, Biddeford, ME \*\* Iterative Polyketide Synthase (IPKS) Conference, Banff, Alberta, Canada \*\* Society for Industrial Microbiology, “Fungal Polyketides–Biosynthesis, pathogenesis and Regulation,” Denver, CO \*\* 41<sup>st</sup> IUPAC World Chemistry Congress, Turin, Italy \*\* International Conference on Reactive Intermediates and Unusual Molecules (ISRIUM), Ascona, Switzerland. 2008: Zing Conference “Natural Products,” Antigua \*\* 7<sup>th</sup> U.S–Japan Seminar on the Biosynthesis of Natural Products, La Jolla, CA \*\* Society for Industrial Microbiology, “Natural Product Biosynthesis in Three Dimensions,” San Diego, CA. 2009: Zing Conference “Natural Products,” Antigua \*\* Society for Industrial Microbiology, “Natural Product Biosynthesis in Three Dimensions,” Toronto, Canada \*\* 42<sup>nd</sup> International Union of Pure & Applied Chemistry (IUPAC) Congress, “Biosynthetic Pathways,” Glasgow, Scotland \*\* National ACS Meeting, BIOL Div. “Natural Products,” Washington, DC \*\* Enzyme Engineering XX “Emerging Applications,” Groningen, NL 2011: International Union of Microbiological Societies (IUMS) Congress 2011, Symposium: “Bioactive Microbial Products,” Sapporo, Japan \*\* Hutchinson Lecture, University of Wisconsin \*\* 2012: International Conference of Natural Product Biosynthesis, 9<sup>th</sup> US–Japan Seminar: “Enzymology•Structural Biology•Drug Discovery•Genome Mining,” Awaji Island, Japan \*\* International Union of Pure & Applied Chemistry, 9<sup>th</sup> International Symposium on Biomolecular Chemistry (ISBOC-9), Beijing, China \*\* Royal Society of Chemistry, “Directing Biosynthesis III,” Royal Society of Chemistry Bioorganic Chemistry Group Lecture, Nottingham, England \*\* 13<sup>th</sup> Annual Connecticut Organic Chemistry Symposium, New Haven, CT \*\* 2013: 6<sup>th</sup> Heron Island Conference on Reactive Intermediates and Unusual Molecules: Synthesis and Mechanism, Heron Island, Australia \*\* DECHEMA, 1<sup>st</sup> European Conference on Natural Products: Research and Applications, Frankfurt-am-Main, Germany \*\* 23<sup>rd</sup> Solvay Conference on Chemistry, Symposium: “New Chemistry and New Opportunities from the Expanding Protein Universe,” Brussels, Belgium \*\* A. I. Scott Medal Symposium, Texas A&M University, College Station, TX \*\* 2014: CBI Lecture, University of Illinois, Champagne-Urbana, IL \*\* 2015: MiCom 2015, 5<sup>th</sup> Int’l Conference on Fungal Communication”, Jena, Germany \*\* UniCat-Lecture, Cluster of Excellence, University of Berlin, Germany \*\* Beilstein Organic Chemistry Conference: Natural Products, Prien-am-Chiemsee, Germany \*\* PacifiChem 2015 Symposium: Natural Products, Honolulu, HI \*\* 2016:

## PUBLICATIONS

1. Scottt, A. I.; Townsend, C. A.; Okada, K.; Kajiwara, M.; Whitman, P. J.; Cushley, R. J. "Biosynthesis of Corrinooids. Concerning the Origin of the Methyl Groups in Vitamin B<sub>12</sub>," *J. Am. Chem. Soc.* **1972**, *94*, 8267–8269.
2. Scott, A. I.; Townsend, C. A.; Okada, K.; Kajiwara, M.; Cushley, R. J. "Uroporphyrinogen III as a Precursor of Vitamin B<sub>12</sub>," *J. Am. Chem. Soc.* **1972**, *94*, 8269–8271.
3. Scott, A. I.; Townsend, C. A.; Okada, K.; Kajiwara, M. "Concerning the Biosynthesis of Vitamin B<sub>12</sub>," *Trans. N.Y. Acad. Sci., Series II* **1973**, *35*, 72–79.
4. Scott, A. I.; Townsend, C. A.; Cushley, R. J. "Stereochemistry of Methyl Group Insertion in Corrinooid Biosynthesis. Determination of Carbon Isotope Chirality by <sup>13</sup>C Nuclear Magnetic Resonance," *J. Am. Chem. Soc.* **1973**, *95*, 5759–5761.
5. Scott, A. I.; Lee, E.; Townsend, C. A. "On Corrin Biosynthesis," *Bioorg. Chem.* **1973**, *3*, 229–237.

6. Scott, A. I.; Townsend, C. A.; Okada, K.; Kajiwara, M. "Biosynthesis of Corrins I. Experiments with  $^{14}\text{C}$ -Porphobilinogen and  $^{14}\text{C}$ -Uroporphyrinogens," *J. Am. Chem. Soc.* **1974**, *96*, 8054–8069.
7. Scott, A. I.; Townsend, C. A.; Okada, K.; Kajiwara, M.; Cushley, R. J.; Whitman, P. J. "Biosynthesis of Corrins II. Incorporation of  $^{13}\text{C}$ -Labeled Substrates into Vitamin B<sub>12</sub>," *J. Am. Chem. Soc.* **1974**, *96*, 8069–8080.
8. Scott, A. I.; Georgopapadakou, N.; Ho, K. S.; Klioze, S.; Lee, E.; Lee, S. L.; Temme, G. H. III; Townsend, C. A.; Armitage, I. M. "Concerning the Intermediacy of Uro'gen III and of a Heptacarboxylic Uro'gen in Corrinoid Biosynthesis," *J. Am. Chem. Soc.* **1975**, *97*, 2548–4550.
9. Townsend, C. A.; Scholl, T.; Arigoni, D. "A New Synthesis of Chiral Acetic Acid," *J. Chem. Soc., Chem. Commun.* **1975**, 921–922.
10. Imfeld, M.; Townsend, C. A.; Arigoni, D. "Intact Transfer of Methyl Groups in the Biosynthesis of Vitamin B<sub>12</sub>," *J. Chem. Soc., Chem. Commun.* **1976**, 541–542.
11. Townsend, C. A.; Theis, A. B. "A Method for the Transfer of Labeled Methyl Groups," *J. Org. Chem.* **1980**, *45*, 1697–1699.
12. Theis, A. B.; Townsend, C. A. "A Simple, Inexpensive Preparation of Highly Pure Copper (I) Bromide and its Dimethylsulfide Complex," *Synth. Commun.* **1981**, *11*, 157–166.
13. Townsend, C. A.; Brown, A. M. "Biosynthetic Studies of Nocardicin A," *J. Am. Chem. Soc.* **1981**, *103*, 2873–2874.
14. Townsend, C. A.; Nguyen, L. T. "Asymmetric, Biogenetically Modeled Synthesis of (-)-3-Aminonocardinic Acid," *J. Am. Chem. Soc.* **1981**, *103*, 4582–4583.
15. Townsend, C. A.; Bloom, L. M. "Studies of Methoxymethyl-Directed Metalation," *Tetrahedron Lett.* **1981**, *22*, 3923–3924.
16. Townsend, C. A.; Davis, S. G.; Christensen, S. B.; Link, J. C.; Lewis, C. P. "Methoxymethyl-Directed Aryl Metalation. A Total Synthesis of (±)-Averufin," *J. Am. Chem. Soc.* **1981**, *103*, 6885–6888.
17. Townsend, C. A.; Neese, A. S.; Theis, A. B. "Synthesis of (3*R*,4*S*)-and(3*R*,4*R*)-[4-<sup>2</sup>H,<sup>3</sup>H]Valine. Preparation of Compounds Containing Chiral-Methyl Groups with an Adjacent Asymmetric Centre," *J. Chem. Soc., Chem. Commun.* **1982**, 116–118.
18. Townsend, C. A.; Brown, A. M. "Nocardicin A Biosynthesis: Stereochemical Course of Monocyclic β-Lactam Formation," *J. Am. Chem. Soc.* **1982**, *104*, 1748–1750.
19. Townsend, C. A.; Nguyen, L. T. "Improved Asymmetric Synthesis of (-)-3-Aminonocardinic Acid and Further Observations of the Mitsunobu Reaction for β-Lactam Formation in Seryl Peptides," *Tetrahedron Lett.* **1982**, *23*, 4859–4862.
20. Townsend, C. A.; Christensen, S. B.; Davis, S. G. "Bisfuran Formation in Aflatoxin Biosynthesis: The Fate of the Averufin Side Chain," *J. Am. Chem. Soc.* **1982**, *104*, 6152–6153.

21. Townsend, C. A.; Christensen, S. B.; Davis, S. G. "Bisfuran Formation in Aflatoxin Biosynthesis: The Role of Versiconal Acetate," *J. Am. Chem. Soc.* **1982**, *104*, 6154–6155.
22. Townsend, C. A.; Brown, A. M. "Nocardicin A: Biosynthetic Experiments with Amino Acid Precursors," *J. Am. Chem. Soc.* **1983**, *105*, 913–918.
23. Townsend, C. A.; Brown, A. M.; Nguyen, L. T. "Nocardicin A: Stereochemical and Biomimetic Studies of Monocyclic  $\beta$ -Lactam Biosynthesis," *J. Am. Chem. Soc.* **1983**, *105*, 919–927.
24. Townsend, C. A.; Christensen, S. B. "Stable Isotope Studies of Anthraquinone Intermediates in the Aflatoxin Pathway," A Symposium-in-Print, *Tetrahedron* **1983**, *39*, 3575-3582.
25. Townsend, C. A.; Davis, S. G. "The Regiochemistry of A-Ring-labelled Averufin Incorporation into Aflatoxin B<sub>1</sub>," *J. Chem. Soc., Chem. Commun.* **1983**, 1420–1422.
26. Townsend, C. A.; Christensen, S. B.; Trautwein, K. "Hexanoate as a Starter Unit in Polyketide Biosynthesis," *J. Am. Chem. Soc.* **1984**, *106*, 3868–3869.
27. Schwab, J. M.; Li, W.-b.; Ho, C.-k.; Townsend, C. A.; Salituro, G. M. "Direct Observation by Carbon-13 NMR Spectroscopy of the Regioselectivity and Stoichiometry of 'Suicide' Enzyme Inactivation," *J. Am. Chem. Soc.* **1984**, *106*, 7293–7294.
28. Townsend, C. A.; Barrabee, E. B. "Stereochemical Investigation of the  $\alpha$ -Ketoglutarate-Dependent 3'-Hydroxylation in Cephalosporin Biosynthesis," *J. Chem. Soc., Chem. Commun.* **1984**, 1586–1588.
29. Townsend, C. A.; Salituro, G. M. "Fate of <sup>15</sup>N-(*p*-Hydroxyphenyl)glycine in Nocardicin A Biosynthesis," *J. Chem. Soc., Chem. Commun.* **1984**, 1631–1632.
30. Townsend, C. A.; Christensen, S. B. "Concerning the Role of Nidurufin in Aflatoxin Biosynthesis," *J. Am. Chem. Soc.* **1985**, *107*, 270–271.
31. Townsend, C. A.; Ho, M.-f. "Biosynthesis of Clavulanic Acid: Origin of the C<sub>5</sub>-Unit," *J. Am. Chem. Soc.* **1985**, *107*, 1065–1066.
32. Townsend, C. A.; Ho, M.-f. "Biosynthesis of Clavulanic Acid: Origin of the C<sub>3</sub>-Unit," *J. Am. Chem. Soc.* **1985**, *107*, 1066–1068.
33. Townsend, C. A.; Theis, A. B.; Neese, A. S.; Barrabee, E. B.; Poland, D. "Stereochemical Fate of Chiral-Methyl Valine in the Ring Expansion of Penicillin N to Deacetoxycephalosporin C," *J. Am. Chem. Soc.* **1985**, *107*, 4760–4767.
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35. Townsend, C. A.; Davis, S. G.; Koreeda, M.; Hulin, B. "A Cationic Model of the Chain-Branching Step in Aflatoxin Biosynthesis," *J. Org. Chem.* **1985**, *50*, 5428–5430.
36. Townsend, C. A.; "The Stereochemical Fate of Chiral-Methyl Valines in Cephalosporin C Biosynthesis," Plenary Lecture at the International Research Congress on Natural Products, July, 1985, *J. Nat. Prod.* **1985**, *48*, 708–724.

37. Townsend, C. A. "Progress Toward a Biosynthetic Rationale of the Aflatoxin Pathway," *Pure & Appl. Chem.* **1986**, 58, 227–238.
38. Townsend, C. A.; Ho, M.-f.; Mao, S.-s. "The Stereochemical Fate of (2*RS*,5*R*)- and (2*RS*,5*S*)-[5-<sup>3</sup>H]Ornithine in Clavulanic Acid Biosynthesis," *J. Chem. Soc., Chem. Commun.* **1986**, 639–639.
39. Townsend, C. A.; Christensen, S. B. "Stereochemical Correlation of (-)-Averantin," *Tetrahedron Lett.* **1986**, 27, 887–888.
40. Schwab, J. M.; Ho, C.-k.; Li, W.-b.; Townsend, C. A.; Salituro, G. M. "β-Hydroxydecanoyl Thioester Dehydrase. Complete Characterization of the Fate of the 'Suicide' Substrate, 3-Decynoyl-NAC," *J. Am. Chem. Soc.* **1986**, 108, 5309–5316.
41. Townsend, C. A.; Salituro, G. M.; Nguyen, L. T.; DiNovi, M. J. "Biogenetically-Modelled Total Syntheses of (-)-Nocardicin A and (-)-Nocardicin G," *Tetrahedron Lett.* **1986**, 27, 3819–3822.
42. Townsend, C. A.; Mao, S.-s. "Clavulanic Acid Biosynthesis: The Stereochemical Course of β-Lactam Formation from Chiral Glycerol," *J. Chem. Soc., Chem. Commun.* **1987**, 86–89.
43. Townsend, C. A.; Christensen, S. B.; Davis, S. G. "Synthesis of Averufin and Its Role in Aflatoxin B<sub>1</sub> Biosynthesis," *J. Chem. Soc., Perkin Trans. I* **1988**, 839–861.
44. Townsend, C. A.; Brobst, S. W.; Ramer, S. E.; Vederas, J. C. "Stereochemical Features of Enoyl Thioester Reductase in Averufin and Fatty Acid Biosynthesis in *Aspergillus parasiticus*," *J. Am. Chem. Soc.* **1988**, 110, 318–319.
45. Townsend, C. A.; Plavcan, K. A.; Pal, K.; Brobst, S. W.; Irish, M. S.; Ely, Jr., E. W.; Bennett, J. W. "Hydroxyversicolorone: Isolation and Characterization of a Potential Intermediate in Aflatoxin Biosynthesis," *J. Org. Chem.* **1988**, 53, 2472–2477.
46. Townsend, C. A.; Wilson, B. A. "The Role of Nocardicin G in Nocardicin A Biosynthesis," *J. Am. Chem. Soc.* **1988**, 110, 3320–3321.
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48. Townsend, C. A.; Krol, W. J. "The Role of Molecular Oxygen in Clavulanic Acid Biosynthesis: Evidence for a Bacterial Oxidative Deamination," *J. Chem. Soc., Chem. Commun.* **1988**, 1234–1236.
49. Townsend, C. A.; Holbrooks, A. McE.; Salituro, G. M. "Stereochemical Fate of (2*S*,4*R*)- and (2*S*,4*S*)-[4-<sup>2</sup>H]Methionine in Nocardicin A Biosynthesis," *J. Chem. Soc., Chem. Commun.* **1988**, 1579–1581.
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51. Townsend, C. A.; Isomura, Y.; Davis, S. G. "Reaction Models of the Oxidative Rearrangement of Averufin to 1'-Hydroxyversicolorone: The First Step in Dihydrobisfuran

- Formation in Aflatoxin Biosynthesis," A Symposium-in-Print, *Tetrahedron* **1989**, *45*, 2263-2276.
52. Krol, W. J.; Basak, A.; Salowe, S. P.; Townsend, C. A. "Oxidative Cyclization Chemistry Catalyzed by Clavaminic Synthetase," *J. Am. Chem. Soc.* **1989**, *111*, 7625-7627.
  53. Graybill, T. L.; Pal, K.; McGuire, S. M.; Brobst, S. W.; Townsend, C. A. "The Timing of Aromatic Deoxygenation in Aflatoxin Biosynthesis," *J. Am. Chem. Soc.* **1989**, *111*, 8306-8308.
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  62. Townsend, C. A.; Basak, A. "Experiments and Speculations on the Role of Oxidative Cyclization Chemistry in Natural Product Biosynthesis," A Symposium-in-Print, *Tetrahedron* **1991**, *47*, 2591-2602.
  63. Cramer, K. D.; Townsend, C. A. "Kinetics of Trisulfide Cleavage in Calicheamicin—Assessing the Role of the Ethylamino Group," *Tetrahedron Lett.* **1991**, *32*, 4635-4638.
  64. Townsend, C. A.; McGuire, S. M.; Brobst, S. W.; Graybill, T. L.; Pal, K.; Barry III, C. E. "Examination of Tetrahydro- and Dihydrobisfuran Formation in Aflatoxin Biosynthesis from Whole Cells to Purified Enzymes." In *ACS Symposium Series, Secondary-Metabolite Biosynthesis and Metabolism*; Petroski, R. J.; McCormick, S. P., Eds.; Plenum Press: New York, 1992; pp. 141-154.



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