

[Home](#) > [Journal](#) > [Earth & Environmental Sciences](#) > [JEP](#)
[Indexing](#) | [View Papers](#) | [Aims & Scope](#) | [Editorial Board](#) | [Guideline](#) | [Article Processing Charges](#)
[JEP](#) > Vol.2 No.6, August 2011



Growth and Toxin Production by *Microcystis Aeruginosa* PCC 7806 (Kutzing) Lemmerman at Elevated Salt Concentrations

PDF (Size: 346KB) PP. 669-674 DOI : 10.4236/jep.2011.26077

Author(s)

Ken Black, Mete Yilmaz, Edward J. Philips

ABSTRACT

One of the most common and widespread bloom-forming cyanobacteria associated with toxin production is *Microcystis aeruginosa* (Kutzing) Lemmerman. While normally associated with fresh water environments, this toxigenic species has been observed at bloom concentrations in a number of major estuaries worldwide. This study examined the effect of salinity on growth and toxin production by *M. aeruginosa* strain PCC 7806 under controlled laboratory conditions. Salt concentrations above 12.6 ppt resulted in total cessation of growth. Toxin production was similarly affected, with cultures grown in salt concentrations of 4.6 ppt and above yielding less toxin than the control after 20 days of culture. Toxin concentrations after 20 days of culture were 40% of the control at 4.6 ppt. The relative proportion of extracellular to intracellular toxin increased over time in cultures with salt concentrations greater than 4.6 ppt. Extracellular toxins persisted in the media long after the cessation of growth. The results suggest that the influence of *M. aeruginosa* and/or its toxins can extend well out into estuarine environments under the influence of significant freshwater inputs.

KEYWORDS

Microcystin, Cyanobacteria, Estuaries

Cite this paper

K. Black, M. Yilmaz and E. Philips, "Growth and Toxin Production by *Microcystis Aeruginosa* PCC 7806 (Kutzing) Lemmerman at Elevated Salt Concentrations," *Journal of Environmental Protection*, Vol. 2 No. 6, 2011, pp. 669-674. doi: 10.4236/jep.2011.26077.

References

- [1] W. W. Carmichael. " Toxic Microcystis and the Environment," In: M. F. Watanabe, K. Harada, W. W. Carmichael and H. Fujiki, Eds., Toxic Microcystis, CRC Press, Boca Raton, 1996.
- [2] H. W. Paerl, R. S. Fulton, P. H. Moisander and J. Dyble, " Harmful Freshwater Algal Blooms, with an Emphasis on Cyanobacteria," The Scientific World Journal, Vol. 1, 2001, pp. 76-113.
- [3] R. W. Zurawell, H. Chen, J. M. Burke and E. E. Prepas, " Hepatotoxic Cyanobacteria: A Review of the Biological Importance of Microcystins in Freshwater Environments," Journal of Toxicology and Environmental Health, Part B, Vol. 8, No. 1, 2005, pp. 1-37.
- [4] I. Chorus and J. Bartram, " Toxic Cyanobacteria in Water: A Guide to Their Public Health Consequences, Monitoring, and Management," E & FN Spon, London, 1999. doi:10.4324/9780203478073
- [5] K. Kaya. " Toxicology of Microcystins," In: M.F. Watanabe, K. Harada, W. W. Carmichael and H. Fujiki, Eds., Toxic Microcystis, CRC Press, Boca Raton, 1996.
- [6] C. Wiegand and S. Pflugmacher, " Ecotoxicological Effects of Selected Cyanobacterial Secondary Metabolites: A Short Review," Toxicology and Applied Pharmacology, Vol. 203, No. 3, 2005, pp. 201-218. doi: 10.1016/j.taap.2004.11.002
- [7] W. W. Carmichael, S. M. Azevedo, J. S. An, R. J. Molica, E. M. Jochimsen, S. Lau, K. L. Rinehart, G. R.

- [Open Special Issues](#)
- [Published Special Issues](#)
- [Special Issues Guideline](#)

[JEP Subscription](#)
[Most popular papers in JEP](#)
[About JEP News](#)
[Frequently Asked Questions](#)
[Recommend to Peers](#)
[Recommend to Library](#)
[Contact Us](#)

Downloads:	301,518
Visits:	674,165

[Sponsors, Associates, and Links >>](#)

- [The International Conference on Pollution and Treatment Technology \(PTT 2013\)](#)

Shaw and G. K. Eaglesham, " Human Fatalities from Cyanobacteria: Chemical and Biological Evidence for Cyanotoxins," *Environmental Health Perspectives*, Vol. 109, No. 7, 2001, pp. 663-668. doi:10.1289/ehp.01109663

- [8] J. H. Landsberg, " The Effects of Harmful Algal Blooms on Aquatic Organisms," *Reviews in Fisheries Science*, Vol. 10, No. 2, 2002, pp. 113-390. doi:10.1080/20026491051695
- [9] I. Chorus, " Cyanobacterial Toxin Research and Its Application in Germany: A Review of the Current Status," *Environmental Toxicology*, Vol. 17, No. 4, 2002, pp. 358- 360. doi:10.1002/tox.10072
- [10] S. H. White, L. J. Duivenvoorden and L. D. Fabbro, " A Decision-Making Framework for Ecological Impacts Associated with the Accumulation of Cyanotoxins (Cylindrospermopsin and Microcystin)," *Lake and Reservoir Management*, Vol. 10, No. 1, 2005, pp. 25-37. doi:10.1111/j.1440-1770.2005.00258.x
- [11] B. W. Ibelings and K. E. Havens, " Cyanobacterial Toxins: A Qualitative Meta-Analysis of Concentrations, Dosage, and Effects in Freshwater and Marine Biota," *Advances in Experimental Medicine and Biology*, Vol. 619, 2008, pp. 675-732. doi:10.1007/978-0-387-75865-7_32
- [12] E. M. Jochimsen, W. W. Carmichael, J. S. An, D. M. Cardo, S. T. Cookson, C. E. Holmes, M. B. Antunes, D. A. de Melo Filho, T. M. Lyra, V. S. Barreto, S. M. Azevedo and W. R. Jarvis, " Liver Failure and Death after Exposure to Microcystins at a Hemodialysis Center in Brazil," *The New England Journal of Medicine*, Vol. 338, No. 13, 1998, pp. 873-878. doi:10.1056/NEJM199803263381304
- [13] P. J. Oberholster, A. Botha and J. U. Grobbelaar, " Microcystis Aeruginosa: Source of Toxic Microcystins in Drinking Water," *African Journal of Biotechnology*, Vol. 3, No. 3, 2004, pp. 159-168.
- [14] C. Svrcek and D. W. Smith, " Cyanobacteria Toxins and the Current State of Knowledge on Water Treatment Options: A Review," *Journal of Environmental Engineering and Science* Vol. 3, No. 3, 2004, pp. 155-185. doi:10.1139/s04-010
- [15] P. W. Lehman, G. Boyer, C. Hall, S. Waller and K. Gerhts, " Distribution and Toxicity of a New Colonial Microcystis Aeruginosa Bloom in the San Francisco Bay Estuary, California," *Hydrobiologia*, Vol. 541, No. 1, 2005, pp. 87-99. doi:10.1007/s10750-004-4670-0
- [16] V. N. Nikulina, " Seasonal Dynamics of Phytoplankton in the Inner Neva Estuary in the 1980' s and 1990' s," *Oceanologia*, Vol. 45, 1, 2003, pp. 25-39.
- [17] C. Rocha, H. Galvao and A. Barbosa, " Role of Transient Silicon Limitation in the Development of Cyanobacteria Blooms in the Guadiana Estuary, South-Western Iberia," *Marine Ecology Progress Series*, Vol. 228, 2002, pp. 35- 45. doi:10.3354/meps228035
- [18] R. Atkins, T. Rose, R. S. Brown and M. Robb, " The Microcystis Cyanobacteria Bloom in the Swan River— February 2000," *Water Science and Technology*, Vol. 43, No. 3, 2001, pp. 107-114.
- [19] E. J. Philips, S. Badylak, J. Hart, D. Haurert, J. Lockwood, K. O' Donnell, D. Sun, P. Viveros and M. Yilmaz, " Climatic Influences on Autochthonous and Allochthonous Phytoplankton Blooms in a Subtropical Estuary, St. Lucie Estuary, Florida, USA," *Estuaries and Coasts*, 2011, in Press.
- [20] E. J. Philips, J. Hendrickson, E. L. Quinlan and M. Cichra, " Meteorological Influences on Algal Bloom Potential in a Nutrient-Rich Blackwater River," *Freshwater Biology*, Vol. 52, No. 11, 2007, pp. 2141-2155. doi:10.1111/j.1365-2427.2007.01844.x
- [21] S. Otsuka, S. Suda, R. Li, M. Watanabe, H. Oyaizu, S. Matsumoto and M. Watanabe, " Characterization of Morphospecies and Strains of the Genus Microcystis (Cyanobacteria) for a Reconsideration of Species Classification," *Phycological Research*, Vol. 47, 1999, pp. 189-197. doi:10.1111/j.1440-1835.1999.tb00298.x
- [22] K. G. Sellner, R. V. Lacouture and C. R. Parrish, " Effects of Increasing Salinity on a Cyanobacterial Bloom in the Potomac River Estuary," *Journal of Plankton Research*, Vol. 10, No. 1, 1988, pp. 49-61. doi:10.1093/plankt/10.1.49
- [23] L. Tonk, K. Bosch, P. M. Visser and J. Huisman, " Salt Tolerance of the Harmful Cyanobacterium Microcystis Aeruginosa," *Aquatic Microbial Ecology*, Vol. 46, No. 2, 2007, pp. 117-123. doi:10.3354/ame046117
- [24] P. T. Orr, G. J. Jones and G. B. Douglas, " Response of Cultured Microcystis Aeruginosa from the Swan River, Australia, to Elevated Salt Concentration and Consequences for Bloom and Toxin Management in Estuaries," *Marine and Freshwater Research*, Vol. 55, No. 3, 2004, pp. 277-283. doi:10.1071/MF03164

- [25] J. A. Baker, B. A. Neilan, B. Entsch and D. B. McKay, " Identification of Cyanobacteria and Their Toxicity in Environmental Samples by Rapid Molecular Analysis," *Environmental Toxicology*, Vol. 16, No. 6, 2001, pp. 472-482. doi:10.1002/tox.10010
- [26] D. Schatz, Y. Keren, O. Hadas, S. Carmeli, A. Sukenik and A. Kaplan, " Ecological Implications of the Emergence of Non-Toxic Subcultures from Toxic Microcystis Strains," *Environmental Microbiology*, Vol. 7, No. 6, 2005, pp. 798-805. doi:10.1111/j.1462-2920.2005.00752.x
- [27] K. R. James, B. Cant and T. Ryan, " Responses of Freshwater Biota to Rising Salinity Levels and Implications for Saline Water Management: A Review," *Australian Journal of Botany*, Vol. 51, 2003, pp. 703-713. doi:10.1071/BT02110
- [28] P. T. Orr and G. J. Jones, " Relationship between Microcystin Production and Cell Division Rates in Nitrogen- Limited Microcystis Aeruginosa Cultures," *Limnology and Oceanography*, Vol. 43, No. 7, 1998, pp. 1604-1614. doi:10.4319/lo.1998.43.7.1604
- [29] J. M. Verspagen, J. Passarge, K. D. Johnk, P. M. Visser, L. Peperzak, P. Boers, H. J. Laanbroek and J. Huisman, " Water Management Strategies against Toxic Microcystis Blooms in the Dutch Delta," *Ecological Applications*, Vol. 16, 2006, pp. 313-327. doi:10.1890/04-1953
- [30] D. R. Hoagland and D. L. Arnon, " The Water Culture Method for Growing Plants without Soil," *California Agricultural Experiment Station Circular*, Vol. 347, 1950, pp. 1-32.
- [31] R. E. Slovacek and P. J. Hannan, " In Vivo Fluorescence Determinations of Phytoplankton Chlorophyll A," *Limnology and Oceanography*, Vol. 22, 5, 1977, pp. 919-925. doi:10.4319/lo.1977.22.5.0919
- [32] American Public Health Association (APHA), " Standard Methods for the Examination of Water and Wastewater," American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 19th Ed., Washington D.C., 1995.
- [33] R. J. Porra, W. A. Thompson and P. E. Kriedemann, " Determination of Accurate Extinction Coefficients and Simultaneous-Equations for Assaying Chlorophyll-a and Chlorophyll-b Extracted with 4 Different Solvents— verification of the Concentration of Chlorophyll Standards by Atomic-Absorption Spectroscopy," *Biochimica et Biophysica Acta*, Vol. 975, No. 3, 1989, pp. 384-394. doi:10.1016/S0005-2728(89)80347-0
- [34] H. Utermohl, " Zur vervollkommnung der quantitativen phytoplankton-methodik," *Mitteilungen-Internationale Vereinigung für Theoretische und Angewandte Limnologie*, Vol. 9, 1958, pp. 1-38.
- [35] J. S. Metcalf and G. A. Codd, " Microwave Oven and Boiling Waterbath Extraction of Hepatotoxins from Cyanobacterial Cells," *FEMS Microbiology Letters*, Vol. 184, No. 2, 2000, pp. 241-246. doi:10.1111/j.1574-6968.2000.tb09021.x
- [36] V. F. de Magalhães, R. M. Soares and S. M. F. O. Azevedo, " Microcystin Contamination in Fish from the Jacarepaguá Lagoon (Rio de Janeiro, Brazil): Ecological Implication and Human Health Risk," *Toxicon*, Vol. 39, No. 7, 2001, pp. 1077-1085. doi:10.1016/S0041-0101(00)00251-8
- [37] M. F. Watanabe, K. Tsuji, Y. Watanabe, K. Harada and M. Suzuki, " Release of Heptapeptide Toxin (Microcystin) during the Decomposition Process of Microcystis Aeruginosa," *Natural Toxins*, Vol. 1, 1992, pp. 48-53. doi:10.1002/nt.2620010110
- [38] I. R. Falconer, A. Choice and W. Hosja, " Toxicity of the Edible Mussel (*Mytilus edulis*) Growing Naturally in an Estuary during a Water-Bloom of Blue-Green Alga *Nodularia Spumigena*," *Journal of Environmental Toxicology and Water Quality*, Vol. 7, No. 2, 1992, pp. 119-123. doi:10.1002/tox.2530070203
- [39] E. E. Prepas, B. G. Kotak, L. M. Campbell, J. C. Evans, S. E. Hruday and C. F. B. Holmes, " Accumulation and Elimination of Cyanobacterial Hepatotoxins by the Freshwater Clam *Anodonta Grandis Simpsoniana*," *Canadian Journal of Fisheries and Aquatic Sciences*, Vol. 54, 1997, pp. 41-46.
- [40] M. F. Watanabe, H. D. Park, F. Kondo, K. Harada, H. Hayashi and T. Okino, " Identification and Estimation of Microcystins in Freshwater Mussels," *Natural Toxins*, Vol. 5, 1997, pp. 31-35. doi:10.1002/(SICI)(1997)5:1<31::AID-NT5>3.0.CO;2-X