



UvA-DARE (Digital Academic Repository)

Shades of red and green : the colorful diversity and ecology of picocyanobacteria in the Baltic Sea

Haverkamp, T.H.A.

Publication date
2008

[Link to publication](#)

Citation for published version (APA):

Haverkamp, T. H. A. (2008). *Shades of red and green : the colorful diversity and ecology of picocyanobacteria in the Baltic Sea*. [Thesis, externally prepared, Universiteit van Amsterdam]. Netherlands Institute of Ecology (NIOO) - Royal Netherlands Academy of Arts and Sciences.

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, P.O. Box 19185, 1000 GD Amsterdam, The Netherlands. You will be contacted as soon as possible.

Chapter 9

References

- Acinas SG, Klepac-Ceraj V, Hunt DE, Pharino C, Ceraj I, Distel DL *et al.* (2004). Fine-scale phylogenetic architecture of a complex bacterial community. *Nature* **430**: 551-554.
- Agawin NSR, Rabouille S, Veldhuis MJW, Servatius L, Hol S, van Overzee HMJ *et al.* (2007). Competition and facilitation between unicellular nitrogen-fixing cyanobacteria and non-nitrogen-fixing phytoplankton species. *Limnol Oceanogr* **52**: 2233-2248.
- Ahlgren NA, Rocap G. (2006). Culture isolation and culture-independent clone libraries reveal new marine *Synechococcus* ecotypes with distinctive light and N physiologies. *Appl Environ Microbiol* **72**: 7193-7204.
- Al-Najjar T, Badran MI, Richter C, Meyerhoefer M, Sommer U. (2007). Seasonal dynamics of phytoplankton in the Gulf of Aqaba, Red Sea. *Hydrobiologia* **579**: 69-83.
- Albertano P, DiSomma D, Capucci E. (1997). Cyanobacterial picoplankton from the Central Baltic Sea: cell size classification by image-analyzed fluorescence microscopy. *J Plankton Res* **19**: 1405-1416.
- Alberte RS, Wood AM, Kursar TA, Guillard RRL. (1984). Novel phycoerythrins in marine *Synechococcus* spp.: characterization and evolutionary and ecological implications. *Plant Physiol* **75**: 732-739.
- Allewalt JP, Bateson MM, Revsbech NP, Slack K, Ward DM. (2006). Effect of temperature and light on growth of and photosynthesis by *Synechococcus* isolates typical of those predominating in the octopus spring microbial mat community of Yellowstone National Park. *Appl Environ Microbiol* **72**: 544-550.
- Alonso C, Warnecke F, Amann R, Pernthaler J. (2007). High local and global diversity of *Flavobacteria* in marine plankton. *Environ Microbiol* **9**: 1253-1266.
- Altschul SF, Gish W, Miller W, Myers EW, and Lipman DJ. (1990). Basic Local Alignment Search Tool. *J Mol Biol* **215**: 403-410.
- Altschul SF, Madden TL, Zhang J, Lipman DJ, Schäffer AA, Zhang Z *et al.* (1997). Gapped BLAST and PSI-BLAST: A new generation of protein database search programs. *Nucleic Acids Res* **25**: 3389-3402.
- Appukuttan D, Rao AS, Apte SK. (2006). Engineering of *Deinococcus radiodurans* R1 for bioprecipitation of uranium from dilute nuclear waste. *Appl Environ Microbiol* **72**: 7873-7878.
- Banerjee T, Ghosh TC. (2006). Gene expression level shapes the amino acid usages in *Prochlorococcus marinus* MED4. *J Biomol Struct Dyn* **23**: 547-553.
- Becker S, Singh AK, Postius C, Böger P, Ernst A. (2004). Genetic diversity and distribution of periphytic *Synechococcus* spp. in biofilms and picoplankton of Lake Constance. *FEMS Microbiol Ecol* **49**: 181-190.
- Béjà O, Spudich EN, Spudich JL, Leclerc M, DeLong EF. (2001). Proteorhodopsin phototrophy in the ocean. *Nature* **411**: 786-789.
- Bergman B, Gallon JR, Rai AN, Stal LJ. (1997). N₂ fixation by non-heterocystous cyanobacteria. *FEMS Microbiol Rev* **19**: 139-185.
- Beiko RG, Harlow TJ, Ragan MA. (2005). Highways of gene sharing in prokaryotes. *Proc Natl Acad Sci USA* **102**: 14332-14337.

- Biegala IC, Not F, Vaultot D, Simon N. (2003). Quantitative assessment of picoeukaryotes in the natural environment by using taxon-specific oligonucleotide probes in association with tyramide signal amplification-fluorescence in situ hybridization and flow cytometry. *Appl Environ Microbiol* **69**: 5519-5529.
- Blank CE, Cady SL, Pace NR. (2002). Microbial composition of near-boiling silica-depositing thermal springs throughout Yellowstone National Park. *Appl Environ Microbiol* **68**: 5123-5135.
- Boone DR, Castenholz RW. (2001). *The archaea and the deeply branching and phototrophic bacteria*. New York: Springer-Verlag
- Brahamsha B. (1996). A genetic manipulation system for oceanic cyanobacteria of the genus *Synechococcus*. *Appl Environ Microbiol* **62**: 1747-1751.
- Bricaud A, Morel A, Prieur L. (1981). Absorption by dissolved organic matter of the sea (yellow substance) in the UV and visible domains. *Limnol. Oceanogr.* **26**: 43-53.
- Bricaud A, Morel A, Prieur L. (1983). Optical efficiency factors of some phytoplankters. *Limnol. Oceanogr.* **28**: 816-832.
- Bruns A, Cypionka H, Overmann J. (2002). Cyclic AMP and acyl homoserine lactones increase the cultivation efficiency of heterotrophic bacteria from the central Baltic Sea. *Appl Environ Microbiol* **68**: 3978-3987.
- Burns RA, MacDonald CD, McGinn PJ, Campbell DA. (2005). Inorganic carbon depletion disrupts photosynthetic acclimation to low temperature in the cyanobacterium *Synechococcus elongatus*. *J Phycol* **41**: 322-334.
- Burns RA, MacKenzie TDB, Campbell DA. (2006). Inorganic carbon depletion constrains steady-state light acclimation in the cyanobacterium *Synechococcus elongatus*. *J Phycol* **42**: 610-621.
- Button DK, Schut F, Quang P, Martin R, Robertson BR. (1993). Viability and isolation of marine bacteria by dilution culture: theory, procedures, and initial results. *Appl Environ Microbiol* **59**: 881-891.
- Campbell L, Carpenter EJ. (1987). Characterization of phycoerythrin-containing *Synechococcus* spp. populations by immunofluorescence. *J Plankton Res* **9**: 1167-1181.
- Campbell L, Vaultot D. (1993). Photosynthetic picoplankton community structure in the subtropical North Pacific Ocean near Hawaii (station Aloha). *Deep-Sea Res pt I* **40**: 2043-2060.
- Campbell L, Landry MR, Constantinou J, Nolla HA, Brown SL, Liu H *et al.* (1998). Response of microbial community structure to environmental forcing in the Arabian Sea. *Deep Sea Res Part II Top Stud Oceanogr* **45**: 2301-2325.
- Carbone A, Kepes F, Zinovyev A. (2005). Codon bias signatures, organization of microorganisms in codon space, and lifestyle. *Mol Biol Evol* **22**: 547-561.
- Castenholz RW, Rippka R, Herdman M, Wilmotte A. (2001). Form-genus XII. Pseudanabaena Lauterborn 1916. In: Boone DR and Castenholz RW (eds) *Bergey's Manual of Systematic Bacteriology*. Second edition, Springer Verlag, Heidelberg, pp 554-557.
- Chao A, Lee SM. (1992). Estimating the number of classes via sample coverage. *J Am Stat Assoc* **87**: 210-217.

- Chen F, Wang K, Kan J, Bachoon DS, Lu J, Lau S *et al.* (2004). Phylogenetic diversity of *Synechococcus* in the Chesapeake Bay revealed by Ribulose-1,5-bisphosphate carboxylase-oxygenase (RuBisCO) large subunit gene (rbcL) sequences. *Aquat Microb Ecol* **36**: 153-164.
- Chen F, Wang K, Kan JJ, Suzuki MT, Wommack KE. (2006). Diverse and unique picocyanobacteria in Chesapeake Bay, revealed by 16S-23S rRNA internal transcribed spacer sequences. *Appl Environ Microbiol* **72**: 2239-2243.
- Choi IG, Kim SH. (2007). Global extent of horizontal gene transfer. *Proc Natl Acad Sci USA* **104**: 4489-4494.
- Chorus I, Bartram J. (1999). *Toxic Cyanobacteria in Water*. Taylor & Francis: London, UK.
- Chomerat N, Garnier R, Bertrand C, Cazaubon A. (2007). Seasonal succession of cyanoprokaryotes in a hypereutrophic oligo-mesohaline lagoon from the South of France. *Estuar Coast Shelf Sci* **72**: 591-602.
- Cohan FM. (2001). Bacterial species and speciation. *Syst Biol* **50**: 513-524.
- Cohan FM. (2002). What are bacterial species? *Annu Rev Microbiol* **56**: 457-487.
- Cohan FM. (2006). Towards a conceptual and operational union of bacterial systematics, ecology, and evolution. *Philos T Roy Soc B* **361**: 1985-1996.
- Cohan FM, Perry EB. (2007). A systematics for discovering the fundamental units of bacterial diversity. *Curr Biol* **17**: R373-R386.
- Cole JR, Chai B, Farris RJ, Wang Q, Kulam SA, McGarrell DM *et al.* (2005). The Ribosomal Database Project (RDP-II): sequences and tools for high-throughput rRNA analysis. *Nucleic Acids Res* **33**: D294-D296.
- Comeron JM, Aguade M. (1998). An evaluation of measures of synonymous codon usage bias. *J Mol Evol* **47**: 268-274.
- Cannon SA, Giovannoni SJ. (2002). High-throughput methods for culturing microorganisms in very-low-nutrient media yield diverse new marine isolates. *Appl Environ Microbiol* **68**: 3878-3885.
- Crosbie ND, Pockl M, Weisse T. (2003). Dispersal and phylogenetic diversity of nonmarine picocyanobacteria, inferred from 16S rRNA gene and *cpcBA*-intergenic spacer sequence analyses. *Appl Environ Microbiol* **69**: 5716-5721.
- Curtis TP, Sloan WT. (2004). Prokaryotic diversity and its limits: microbial community structure in nature and implications for microbial ecology. *Curr Opin Microbiol* **7**: 221-226.
- Damerval T, Castets AM, Houmard J, Tandeau de Marsac N. (1991). Gas vesicle synthesis in the cyanobacterium *Pseudanabaena* sp.: occurrence of a single photoregulated gene. *Mol Microbiol* **5**: 657-664.
- Darwin CR. (1859). *On the Origin of Species by Means of Natural Selection*. John Murray, London.
- Delorimier R, Wilbanks SM, Glazer AN. (1993). Genes of the R-phycoyanin-II locus of marine *Synechococcus*-spp. and comparison of protein-chromophore interactions in phycoyanins differing in bilin composition. *Plant Mol Biol* **21**: 225-237.
- Diez B, Bauer K, Bergman B. (2007). Epilithic cyanobacterial communities of a marine tropical beach rock (Heron Island, Great Barrier Reef): Diversity and diazotrophy. *Appl Environ Microbiol* **73**: 3656-3668.
- Dokulil MT, Teubner K. (2000). Cyanobacterial dominance in lakes. *Hydrobiologia* **438**: 1-12.

- Dong HL, Rech JA, Jiang HC, Sun H, Buck BJ. (2007). Endolithic cyanobacteria in soil gypsum: Occurrences in Atacama (Chile), Mojave (United States), and Al-Jafr Basin (Jordan) deserts. *J Geophys Res* **112**.
- Engelmann TW. (1883). Farbe und Assimilation. *Bot. Zeit.* **41**: 1-13.
- Ernst A, Becker S, Wollenzien UIA, Postius C. (2003). Ecosystem-dependent adaptive radiations of picocyanobacteria inferred from 16S rRNA and ITS-1 sequence analysis. *Microbiol SGM* **149**: 217-228.
- Ernst A, Deicher M, Herman PMJ, Wollenzien UIA. (2005). Nitrate and phosphate affect cultivability of cyanobacteria from environments with low nutrient levels. *Appl Environ Microbiol* **71**: 3379-3383.
- Everroad C, Six C, Partensky F, Thomas JC, Holtzendorff J, Wood AM. (2006). Biochemical bases of type IV chromatic adaptation in marine *Synechococcus* spp. *J. Bacteriol.* **188**:3345-3356.
- Everroad RC, Wood AM. (2006). Comparative molecular evolution of newly discovered picocyanobacterial strains reveals a phylogenetically informative variable region of beta-phycoerythrin. *J Phycol* **42**: 1300-1311.
- Falkowski PG, Katz ME, Knoll AH, Quigg A, Raven JA, Schofield O *et al.* (2004). The evolution of modern eukaryotic phytoplankton. *Science* **305**: 354-360.
- Feldgarden M, Byrd N, Cohan FM. (2003). Gradual evolution in bacteria: evidence from *Bacillus* systematics. *Microbiol SGM* **149**: 3565-3573.
- Felsenstein J. (1989). PHYLIP - Phylogeny Inference Package (Version 3.2). *Cladistics* **5**: 164-166.
- Ferrari BC, Binnerup SJ, Gillings M. (2005). Microcolony cultivation on a soil substrate membrane system selects for previously uncultured soil bacteria. *Appl Environ Microbiol* **71**: 8714-8720.
- Field KG, Gordon D, Wright T, Rappe M, Urbach E, Vergin K *et al.* (1997). Diversity and depth-specific distribution of SAR11 cluster rRNA genes from marine planktonic bacteria. *Appl Environ Microbiol* **63**: 63-70.
- Foerstner KU, von Mering C, Hooper SD, Bork P. (2005). Environments shape the nucleotide composition of genomes. *EMBO Rep* **6**: 1208-1213.
- Fox, GE, Wisotzkey JD, Jurtshuk, P. (1992). How close is close: 16S rRNA sequence identity may not be sufficient to guarantee species identity. *Int J Syst Bacteriol* **42**: 166-170.
- Fuller NJ, Marie D, Partensky F, Vaulot D, Post AF, Scanlan DJ. (2003). Clade-specific 16S ribosomal DNA oligonucleotides reveal the predominance of a single marine *Synechococcus* clade throughout a stratified water column in the Red Sea. *Appl Environ Microbiol* **69**: 2430-2443.
- Fuller NJ, West NJ, Marie D, Yallop M, Rivlin T, Post AF *et al.* (2005). Dynamics of community structure and phosphate status of picocyanobacterial populations in the Gulf of Aqaba, Red Sea. *Limnol Oceanogr* **50**: 363-375.
- Fuller NJ, Tarran GA, Yallop M, Orcutt KM, Scanlan DJ. (2006). Molecular analysis of picocyanobacterial community structure along an Arabian Sea transect reveals distinct spatial separation of lineages. *Limnol Oceanogr* **51**: 2515-2526.
- Gans J, Wolinsky M, Dunbar J. (2005). Computational improvements reveal great bacterial diversity and high metal toxicity in soil. *Science* **309**: 1387-1390.
- Garcia-Martinez J, Acinas SG, Anton AI, Rodriguez-Valera F. (1999). Use of the 16S-23S ribosomal genes spacer region in studies of prokaryotic diversity. *J Microbiol Methods* **36**: 55-64.

- Gause GF. (1934). *The Struggle for Existence*. Williams & Wilkins, Baltimore.
- Geiss U, Selig U, Schumann R, Steinbruch R, Bastrop R, Hagemann M *et al.* (2004). Investigations on cyanobacterial diversity in a shallow estuary (Southern Baltic Sea) including genes relevant to salinity resistance and iron starvation acclimation. *Environ Microbiol* **6**: 377-387.
- Gevers D, Cohan FM, Lawrence JG, Spratt BG, Coenye T, Feil EJ *et al.* (2005). Re-evaluating prokaryotic species. *Nat Rev Microbiol* **3**: 733-739.
- Gkelis S, Rajaniemi P, Vardaka E, Moustaka-Gouni M, Lanaras T, Sivonen K. (2005). *Limnothrix redekei* (Van Goor) Meffert (Cyanobacteria) strains from Lake Kastoria, Greece form a separate phylogenetic group. *Microb Ecol* **49**: 176-182.
- Glazer AN. (1985). Light harvesting by phycobilisomes. *Annu Rev Biophys Biophys Chem* **14**: 47-77.
- Goo YA, Roach J, Glusman G, Baliga NS, Deutsch K, Pan M *et al.* (2004). Low-pass sequencing for microbial comparative genomics. *BMC Genomics* **5**: 3.
- Good IJ. (1953). The population frequencies of species and the estimation of population parameters. *Biometrika* **40**: 237-264.
- Granéli E, Turner J. (2006). *Ecology of Harmful Marine Algae*. Springer: Berlin, Germany
- Grant PR, Grant BR. (2002). Adaptive radiation of Darwin's finches. *Amer. Scientist* **90**: 130-139.
- Grasshoff K, Ehrhardt M, Kremling K. (1983). *Methods of sea water analysis*, 2nd edn. Verlag Chemie: Weinheim, Germany.
- Grover JP. (1997). *Resource Competition*. Chapman and Hall, London.
- Guillard RR, Lorenzen CJ. (1972). Yellow-green algae with chlorophyllide C. *J Phycol* **8**: 10-14.
- Hall TA. (1999). BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleic Acids Symposium Series* **41**: 95-98.
- Haverkamp T, Acinas SG, Doleman M, Stomp M, Huisman J, Stal LJ. (2008). Diversity and phylogeny of Baltic Sea picocyanobacteria inferred from their ITS and phycobiliprotein operons. *Environ Microbiol* **10**: 174-188.
- Herdman M, Castenholz RW, Iteman I, Waterbury JB, Rippka R. (2001). The *Archaea* and the deeply branching and phototrophic *bacteria*. In *Bergey's Manual of Systematic Bacteriology*, Second Edition, Volume 1. Boone, D.R., and Castenholz, R.W. (eds). Heidelberg, Germany: Springer Verlag, pp. 493-514.
- Hess WR. (2004). Genome analysis of marine photosynthetic microbes and their global role. *Curr Opin Biotechnol* **15**: 191-198.
- Hold GL, Smith EA, Rappe MS, Maas EW, Moore ERB, Stroempl C *et al.* (2001). Characterisation of bacterial communities associated with toxic and non-toxic dinoflagellates: *Alexandrium* spp. and *Scrippsiella trochoidea*. *FEMS Microbiol Ecol* **37**: 161-173.
- Hudson RR, Kreitman M, Aguade M. (1987). A test of neutral molecular evolution based on nucleotide data. *Genetics* **116**: 153-159.
- Hudson RR, Slatkin M, Maddison WP. (1992). Estimation of levels of gene flow from DNA sequence data. *Genetics* **132**: 583-589.
- Huisman J, van Oostveen P, Weissing FJ. (1999). Critical depth and critical turbulence: two different mechanisms for the development of phytoplankton blooms. *Limnol Oceanogr* **44**: 1781-1787.
- Huisman J, Weissing FJ. (1999). Biodiversity of plankton by species oscillations and chaos. *Nature* **402**: 407-410.

- Huisman J, Sharples J, Stroom JM, Visser PM, Kardinaal WEA, Verspagen JMH *et al.* (2004). Changes in turbulent mixing shift competition for light between phytoplankton species. *Ecology* **85**: 2960-2970.
- Huisman J, Matthijs HCP, Visser PM. (2005). *Harmful Cyanobacteria*. Springer: Berlin, Germany
- Huisman J, Pham Thi NN, Karl DM, Sommeijer B. (2006). Reduced mixing generates oscillations and chaos in the oceanic deep chlorophyll maximum. *Nature* **439**: 322-325.
- Hunt DE, Klepac-Ceraj V, Acinas SG, Gautier C, Bertilsson S, Polz MF. (2006). Evaluation of 23S rRNA PCR primers for use in phylogenetic studies of bacterial diversity. *Appl Environ Microbiol* **72**: 2221-2225.
- Huson DH, Bryant D. (2006). Application of phylogenetic networks in evolutionary studies. *Mol Biol Evol* **23**: 254-267.
- Hutchinson GE. (1961). The paradox of the plankton. *Am Nat* **95**: 137-145.
- Hutchinson GE. (1978). *An Introduction to Population Ecology*. Yale Univ. Press, New Haven.
- Irigoiien X, Huisman J, Harris RP. (2004). Global biodiversity patterns of marine phytoplankton and zooplankton. *Nature* **429**: 863-867.
- Islam T, Jensen S, Reigstad LJ, Larsen O, Birkeland NK. (2008). Methane oxidation at 55°C and pH 2 by a thermoacidophilic bacterium belonging to the *Verrucomicrobia* phylum. *Proc Natl Acad Sci USA* **105**: 300-304.
- Iteman I, Rippka R, Tandeau de Marsac N, Herdman M. (2000). Comparison of conserved structural and regulatory domains within divergent 16S rRNA-23S rRNA spacer sequences of cyanobacteria. *Microbiol SGM* **146**: 1275-1286.
- Ivanikova NV, Popels LC, McKay RM, Bullerjahn GS. (2007). Lake Superior supports novel clusters of cyanobacterial picoplankton. *Appl Environ Microbiol* **73**: 4055-65.
- Janssen F, Neumann T, Schmidt M. (2004). Inter-annual variability in cyanobacteria blooms in the Baltic Sea controlled by wintertime hydrographic conditions. *Mar Eco Pro Ser* **275**: 59-68.
- Jezberova J, Komarkova J. (2007). Morphometry and growth of three *Synechococcus*-like picoplanktic cyanobacteria at different culture conditions. *Hydrobiologia* **578**: 17-27.
- Johnson ZI, Zinser ER, Coe A, McNulty NP, Woodward EMS, Chisholm SW. (2006). Niche partitioning among *Prochlorococcus* ecotypes along ocean-scale environmental gradients. *Science* **311**: 1737-1740.
- Jonker RR, Meulemans JT, Dubelaar GBJ, Wilkins MF, Ringelberg J. (1995). Flow cytometry: A powerful tool in analysis of biomass distributions in phytoplankton. *Water Sci Technol* **32**: 177-182.
- Kallas T, Coursin T, Rippka R. (1985). Different organization of *nif* genes in nonheterocystous and heterocystous cyanobacteria. *Plant Mol Biol* **5**: 321-329.
- Kangro K, Olli K, Tamminen T, Lignell R. (2007). Species-specific responses of a cyanobacteria-dominated phytoplankton community to artificial nutrient limitation in the Baltic Sea. *Mar Eco Pro Ser* **336**: 15-27.
- Katano T, Nakano S, Ueno H, Mitamura O, Anbutsu K, Kihira M, *et al.* (2005). Abundance, growth and grazing loss rates of picophytoplankton in Barguzin Bay, Lake Baikal. *Aquat Ecol* **39**: 431-438.
- Kehoe DM, Gutu A. (2006). Responding to color: The regulation of complementary chromatic adaptation. *Annu Rev Plant Biol* **57**: 127-150.

- Kemp PF, Aller JY. (2004). Bacterial diversity in aquatic and other environments: what 16S rDNA libraries can tell us. *FEMS Microbiol Ecol* **47**: 161-177.
- Kilian O, Steunou AS, Fazeli F, Bailey, S, Bhaya D, Grossman AR. (2007). Responses of a thermophilic *Synechococcus* isolate from the microbial mat of octopus spring to light. *Appl Environ Microbiol* **73**: 4268-4278.
- Kim SG, Rhee SK, Ahn CY, Ko SR, Choi GG, Bae JW *et al.* (2006). Determination of cyanobacterial diversity during algal blooms in Daechung Reservoir, Korea, on the basis of *cpcBA* intergenic spacer region analysis. *Appl Environ Microbiol* **72**: 3252-3258.
- Kirk JTO. (1994). *Light and Photosynthesis in Aquatic Ecosystems* (2nd edn). Cambridge, UK: Cambridge University Press.
- Kisand V, Wikner J. (2003). Combining culture-dependent and -independent methodologies for estimation of richness of estuarine bacterioplankton consuming riverine dissolved organic matter. *Appl Environ Microbiol* **69**: 3607-3616.
- Klausmeier CA, Litchman E. (2001). Algal games: the vertical distribution of phytoplankton in poorly mixed water columns. *Limnol. Oceanogr.* **46**: 1998-2007.
- Kogure K, Simidu U, Taga N. (1979). Tentative direct microscopic method for counting living marine-bacteria. *Can J Microbiol* **25**: 415-420.
- Koksharova OA, Wolk CP. (2002). A novel gene that bears a DnaJ motif influences cyanobacterial cell division. *J Bacteriol* **184**: 5524-5528.
- Koksharova OA, Klint J, Rasmussen U. (2007). Comparative proteomics of cell division mutants and wild-type of *Synechococcus* sp strain PCC 7942. *Microbiol SGM* **153**: 2505-2517.
- Komárek J, Kopecký J, Cepák V. (1999). Generic characters of the simplest cyanoprokaryotes *Cyanobium*, *Cyanobacterium* and *Synechococcus*. *Cryptogamie, Algologie* **20**: 209-222.
- Komárek J. (2003). Planktic oscillatorialean cyanoprokaryotes (short review according to combined phenotype and molecular aspects). *Hydrobiologia* **502**: 367-382.
- Konstantinidis KT, Tiedje JM. (2005). Genomic insights that advance the species definition for prokaryotes. *Proc Natl Acad Sci USA* **102**: 2567-2572.
- Konstantinidis KT, Tiedje JM. (2007). Prokaryotic taxonomy and phylogeny in the genomic era: advancements and challenges ahead. *Curr Opin Microbiol* **10**: 504-509.
- Kumar S, Tamura K, Nei M. (2004). MEGA3: Integrated software for molecular evolutionary genetics analysis and sequence alignment. *Brief Bioinform* **5**: 150-163.
- Kuuppo P, Samuelsson K, Lignell R, Seppala J, Tamminen T, Andersson A. (2003). Fate of increased production in late-summer plankton communities due to nutrient enrichment of the Baltic Proper. *Aquat Microb Ecol* **32**: 47-60.
- Lack D. (1974). *Darwin's Finches*. Cambridge Univ. Press, Cambridge.
- Lagus A, Suomela J, Helminen H, Sipura J. (2007). Impacts of nutrient enrichment and sediment on phytoplankton community structure in the northern Baltic Sea. *Hydrobiologia* **579**: 351-368.
- Laloui W, Palinska KA, Rippka R, Partensky F, Tandeau de Marsac N, Herdman M *et al.* (2002). Genotyping of axenic and non-axenic isolates of the genus *Prochlorococcus* and the OMF-'*Synechococcus*' clade by size, sequence analysis or RFLP of the Internal Transcribed Spacer of the ribosomal operon. *Microbiol SGM* **148**: 453-465.

- Lane DJ. (1991). 16S/23S rRNA sequencing. In: Stackebrandt E and Goodfellow M (eds) *Nucleic Acid Techniques in Bacterial Systematics*, John Wiley and Sons Ltd, New York, pp 115-147.
- Lavallée BF, Pick FR. (2002). Picocyanobacteria abundance in relation to growth and loss rates in oligotrophic to mesotrophic lakes. *Aquat. Microb. Ecol.* **27**: 37-46.
- Lenski RE, Travisano M. (1994). Dynamics of adaptation and diversification: A 10000-generation experiment with bacterial populations. *Proc. Natl Acad. Sci. USA* **91**: 6808-6814.
- Lewis MR, Warnock RE, Platt T. (1985). Absorption and photosynthetic action spectra for natural phytoplankton populations: implications for production in the open ocean. *Limnol. Oceanogr.* **30**: 794-806.
- Li W, Chomel BB, Maruyama S, Guptil L, Sander A, Raoult D *et al.* (2006). Multispacer typing to study the genotypic distribution of *Bartonella henselae* populations. *J Clin Microbiol* **44**: 2499-506.
- Li WKW, Rao DVS, Harrison WG, Smith JC, Cullen JJ, Irwin B *et al.* (1983). Autotrophic picoplankton in the tropical ocean. *Science* **219**: 292-295.
- Lindell D, Post AF. (1995). Ultraphytoplankton succession is triggered by deep winter mixing in the Gulf-of-Aqaba (Eilat), Red-Sea. *Limnol Oceanogr* **40**: 1130-1141.
- Litchman E. (2003). Competition and coexistence of phytoplankton under fluctuating light: experiments with two cyanobacteria. *Aquat. Microb. Ecol.* **31**: 241-248.
- Litchman E, Klausmeier CA. (2001). Competition of phytoplankton under fluctuating light. *Am. Nat.* **157**: 170-187.
- Lopez-Lopez A, Bartual SG, Stal L, Onyshchenko O, Rodriguez-Valera F. (2005). Genetic analysis of housekeeping genes reveals a deep-sea ecotype of *Alteromonas macleodii* in the Mediterranean Sea. *Environ Microbiol* **7**: 649-659.
- MacArthur R, Levins R. (1967). The limiting similarity, convergence, and divergence of coexisting species. *Am. Nat.* **101**: 377-385.
- Magurran AE. (1988). *Ecological diversity and its measurement*. Princeton, N.J., USA: Princeton University Press.
- Makarova KS, Aravind L, Wolf YI, Tatusov RL, Minton KW, Koonin EV *et al.* (2001). Genome of the extremely radiation-resistant bacterium *Deinococcus radiodurans* viewed from the perspective of comparative genomics. *Microbiol Mol Biol Rev* **65**: 44-79.
- Markowitz VM, Korzeniewski F, Palaniappan K, Szeto E, Werner G, Padki A *et al.* (2006). The integrated microbial genomes (IMG) system. *Nucleic Acids Res* **34**: D344-D348.
- Massana R, Murray AE, Preston CM, DeLong EF. (1997). Vertical distribution and phylogenetic characterization of marine planktonic Archaea in the Santa Barbara Channel. *Appl Environ Microbiol* **63**: 50-56.
- Mayer J, Dokulil MT, Salbrechter M, Berger M, Posch T, Pfister G *et al.* (1997). Seasonal successions and trophic relations between phytoplankton, zooplankton, ciliate and bacteria in a hypertrophic shallow lake in Vienna, Austria. *Hydrobiologia* **342**: 165-174.
- McDonald JH, Kreitman M. (1991). Adaptive protein evolution at the *Adh* locus in *Drosophila*. *Nature* **351**: 652-654.
- McGinnis S, Madden TL. (2004). BLAST: at the core of a powerful and diverse set of sequence analysis tools. *Nucleic Acids Res* **32**: W20-W25.

- Miller SR, Purugganan MD, Curtis SE. (2006). Molecular population genetics and phenotypic diversification of two populations of the thermophilic cyanobacterium *Mastigocladus laminosus*. *Appl Environ Microbiol* **72**: 2793-2800.
- Mischke U, Nixdorf B. (2003). Equilibrium phase conditions in shallow German lakes: How cyanoprokaryota species establish a steady state phase in late summer. *Hydrobiologia* **502**: 123-132.
- Miyagishima SY, Wolk CP, Osteryoung KW. (2005). Identification of cyanobacterial cell division genes by comparative and mutational analyses. *Mol Microbiol* **56**: 126-143.
- Moon-van der Staay SY, De Wachter R, Vaulot D. (2001). Oceanic 18S rDNA sequences from picoplankton reveal unsuspected eukaryotic diversity. *Nature* **409**: 607-610.
- Moore LR, Rocap G, Chisholm SW. (1998). Physiology and molecular phylogeny of coexisting *Prochlorococcus* ecotypes. *Nature* **393**: 464-467.
- Moore LR, Chisholm SW. (1999). Photophysiology of the marine cyanobacterium *Prochlorococcus*: Ecotypic differences among cultured isolates. *Limnol Oceanogr* **44**: 628-638.
- Moran XAG. (2007). Annual cycle of picophytoplankton photosynthesis and growth rates in a temperate coastal ecosystem: a major contribution to carbon fluxes. *Aquat Microb Ecol* **49**: 267-279.
- Morris RM, Vergin KL, Cho JC, Rappe MS, Carlson CA, Giovannoni SJ. (2005). Temporal and spatial response of bacterioplankton lineages to annual convective overturn at the Bermuda Atlantic Time-series Study site. *Limnol Oceanogr* **50**: 1687-1696.
- Mózes A, Présing M, Vörös L. (2006). Seasonal dynamics of picocyanobacteria and picoeukaryotes in a large shallow lake (Lake Balaton, Hungary). *Int Rev Hydrobiol* **91**: 38-50.
- Murrell MC, Lores EM. (2004). Phytoplankton and zooplankton seasonal dynamics in a subtropical estuary: importance of cyanobacteria. *J Plankton Res* **26**: 371-382.
- Mühling M, Fuller NJ, Somerfield PJ, Post AF, Wilson WH, Scanlan DJ *et al.* (2006). High resolution genetic diversity studies of marine *Synechococcus* isolates using *rpoCI*-based restriction fragment length polymorphism. *Aquat Microb Ecol* **45**: 263-275.
- Nei M, Kumar S, Takahashi K. (1998). The optimization principle in phylogenetic analysis tends to give incorrect topologies when the number of nucleotides or amino acids used is small. *Proc Natl Acad Sci USA* **95**: 12390-12397.
- Neilan BA, Jacobs D, Goodman AE. (1995). Genetic diversity and phylogeny of toxic cyanobacteria determined by DNA polymorphisms within the phycocyanin locus. *Appl Environ Microbiol* **61**: 3875-3883.
- Nogi Y, Hosoya S, Kato C, Horikoshi K. (2007). *Psychromonas hadalis* sp. nov., a novel plezophilic bacterium isolated from the bottom of the Japan Trench. *Int J Syst Evol Microbiol* **57**: 1360-1364.
- Ohlendieck U, Gundersen K, Meyerhofer M, Fritsche P, Nachtigall K, Bergmann B. (2007). The significance of nitrogen fixation to new production during early summer in the Baltic Sea. *Biogeosciences* **4**: 63-73.
- Olsen GJ, Lane DJ, Giovannoni SJ, Pace NR, Stahl DA. (1986). Microbial ecology and evolution - a ribosomal-RNA approach. *Annu Rev Microbiol* **40**: 337-365.
- Olson, RJ, Chisholm SW, Zettler ER, Armbrust EV. (1990). Pigments, size, and distribution of *Synechococcus* in the North-Atlantic and Pacific Oceans. *Limnol Oceanogr* **35**: 45-58.

- Ong LJ, Glazer AN. (1991). Phycoerythrins of marine unicellular cyanobacteria. 1. Bilin types and locations and energy transfer pathways in *Synechococcus* spp. Phycoerythrins. *J Biol Chem* **266**: 9515-9527.
- Pace NR, Stahl DA, Lane DJ, Olsen GJ. (1986). The analysis of natural microbial populations by ribosomal RNA sequences. *Adv Microb Ecol* **9**: 1-55.
- Pace NR. (1997). A molecular view of microbial diversity and the biosphere. *Science* **276**: 734-740.
- Palenik B. (2001). Chromatic adaptation in marine *Synechococcus* strains. *Appl Environ Microbiol* **67**: 991-994.
- Palenik B, Ren QH, Dupont CL, Myers GS, Heidelberg JF, Badger JH *et al.* (2006). Genome sequence of *Synechococcus* CC9311: Insights into adaptation to a coastal environment. *Proc Natl Acad Sci USA* **103**: 13555-13559.
- Palys T, Nakamura LK, Cohan FM. (1997). Discovery and classification of ecological diversity in the bacterial world: the role of DNA sequence data. *Int J Syst Bacteriol* **47**: 1145-1156.
- Partensky F, Blanchot J, Vaultot D. (1999). Differential distribution and ecology of *Prochlorococcus* and *Synechococcus* in oceanic waters: a review. In *Marine Cyanobacteria* Charpy, L., and Larkum, A.W.D. (eds). Monaco: Bulletin de l'Institut oceanographique, pp. 457-475.
- Passarge J, Hol S, Escher M, Huisman J. (2006). Competition for nutrients and light: stable coexistence, alternative stable states, or competitive exclusion? *Ecol. Monogr.* **76**: 57-72.
- Pedros-Alio C. (2006). Marine microbial diversity: can it be determined? *Trends Microbiol* **14**: 257-263.
- Pick FR. (1991). The abundance and composition of freshwater picocyanobacteria in relation to light penetration. *Limnol Oceanogr* **36**: 1457-1462.
- Platt T, Rao DVS, Irwin B. (1983). Photosynthesis of picoplankton in the oligotrophic ocean. *Nature* **301**: 702-704.
- Ploug H, Kuhl M, Buchholz-Cleven B, Jorgensen BB. (1997). Anoxic aggregates - an ephemeral phenomenon in the pelagic environment? *Aquat Microb Ecol* **13**: 285-294.
- Polz MF, Cavanaugh CM. (1998). Bias in template-to-product ratios in multitemplate PCR. *Appl Environ Microbiol* **64**: 3724-3730.
- Polz MF, Hunt DE, Preheim SP, Weinreich DM. (2006). Patterns and mechanisms of genetic and phenotypic differentiation in marine microbes. *Philos T Roy Soc B* **361**: 2009-2021.
- Pommier T, Canback B, Riemann L, Bostrom KH, Simu K, Lundberg P *et al.* (2007). Global patterns of diversity and community structure in marine bacterioplankton. *Mol Ecol* **16**: 867-880.
- Pope RM, Fry ES. (1997). Absorption spectrum (380-700 nm) of pure water. II. Integrating cavity measurements. *Appl. Opt.* **36**: 8710-8723.
- Postius C, Neuschaefter-Rube O, Haid V, Böger P. (2001). N₂-fixation and complementary chromatic adaptation in non-heterocystous cyanobacteria from Lake Constance. *FEMS Microbiol Ecol* **37**: 117-125.
- Ramsing NB, Ferris MJ, Ward DM. (2000). Highly ordered vertical structure of *Synechococcus* populations within the one-millimeter-thick photic zone of a hot spring cyanobacterial mat. *Appl Environ Microbiol* **66**: 1038-1049.
- Rappe MS, Giovannoni SJ. (2003). The uncultured microbial majority. *Annu Rev Microbiol* **57**: 369-394.

- Riemann L, Leitet C, Pommier T, Simu K, Holmfeldt K, Larsson U, Hagstrom A. (2008). The native bacterioplankton community in the central Baltic sea is influenced by freshwater bacterial species. *Appl Environ Microbiol* **74**: 503-515.
- Rippka R, Deruelles J, Waterbury JB. (1979). Generic assignments, strain histories and properties of pure cultures of cyanobacteria. *J Gen Microbiol* **111**: 1-61.
- Rippka R, Herdman M. (1992). *Pasteur Culture Collection of Cyanobacteria*, vol. 1. Institute Pasteur: Paris, France
- Rippka R, Castenholz RW, Herdman M. (2001). Form-genus IV. *Cyanobium*. In *Bergey's manual of Systematic Bacteriology*. Boone, D.R., and Castenholz, R.W. (eds). Heidelberg: Springer Verlag, pp. 498-499.
- Robertson BR, Tezuka N, Watanabe MM. (2001). Phylogenetic analyses of *Synechococcus* strains (cyanobacteria) using sequences of 16S rDNA and part of the phycocyanin operon reveal multiple evolutionary lines and reflect phycobilin content. *Int J Syst Evol Microbiol* **51**: 861-871.
- Rocap G, Distel DL, Waterbury JB, Chisholm SW. (2002). Resolution of *Prochlorococcus* and *Synechococcus* ecotypes by using 16S-23S ribosomal DNA internal transcribed spacer sequences. *Appl Environ Microbiol* **68**: 1180-1191.
- Rocap G, Larimer FW, Lamerdin J, Malfatti S, Chain P, Ahlgren NA *et al.* (2003). Genome divergence in two *Prochlorococcus* ecotypes reflects oceanic niche differentiation. *Nature* **424**: 1042-1047.
- Romo S, Miracle MR. (1994). Population dynamics and ecology of subdominant phytoplankton species in a shallow hypertrophic lake (Albufera of Valencia, Spain). *Hydrobiologia* **273**: 37-56.
- Rozas J, Sanchez-DelBarrio JC, Messeguer X, Rozas R. (2003). DnaSP, DNA polymorphism analyses by the coalescent and other methods. *Bioinformatics* **19**: 2496-2497.
- Rücker J, Wiedner C, Zippel P. (1997). Factors controlling the dominance of *Planktothrix agardhii* and *Limnothrix redekei* in eutrophic shallow lakes. *Hydrobiologia* **342**: 107-115.
- Rusch DB, Halpern AL, Sutton G, Heidelberg KB, Williamson S, Yooseph S *et al.* (2007). The Sorcerer II Global Ocean Sampling Expedition: Northwest Atlantic through Eastern Tropical Pacific. *Plos Biol* **5**: 398-432.
- Sathyendranath S, Platt T. (1989). Computation of aquatic primary production: extended formalism to include effect of angular and spectral distribution of light. *Limnol. Oceanogr.* **34**: 188-198.
- Sattley WM, Madigan MT. (2007). Cold-active acetogenic bacteria from surficial sediments of perennially ice-covered Lake Fryxell, Antarctica. *FEMS Microbiol Lett* **272**: 48-54.
- Scanlan DJ. (2003). Physiological diversity and niche adaptation in marine *Synechococcus*. *Adv Microb Physiol* **47**: 1-64.
- Schloss PD, Handelsman J. (2005). Introducing DOTUR, a computer program for defining operational taxonomic units and estimating species richness. *Appl Environ Microbiol* **71**: 1501-1506.
- Schmidt TM, Delong EF, Pace NR. (1991). Analysis of a marine picoplankton community by 16S Ribosomal-RNA gene cloning and sequencing. *J Bacteriol* **173**: 4371-4378.
- Schwarz R, Forchhammer K. (2005). Acclimation of unicellular cyanobacteria to macronutrient deficiency: emergence of a complex network of cellular responses. *Microbiol SGM* **151**: 2503-2514.
- Sieracki ME, Viles CL, Webb KL. (1989). Algorithm to estimate cell biovolume using image analyzed microscopy. *Cytometry* **10**: 551-557.

- Shi T, Falkowski PG. (2008). Genome evolution in cyanobacteria: the stable core and the variable shell. *Proc Natl Acad Sci USA* **105**: 2510-2515.
- Singh VK, Mangalam AK, Dwivedi S, Naik S. (1998). Primer premier: Program for design of degenerate primers from a protein sequence. *Biotechniques* **24**: 318-319.
- Singleton DR, Furlong MA, Rathbun SL, Whitman WB. (2001). Quantitative comparisons of 16S rDNA sequence libraries from environmental samples. *Appl Environ Microbiol* **67**: 4373-4376.
- Six C, Thomas JC, Brahamsha B, Lemoine Y, Partensky F. (2004). Photophysiology of the marine cyanobacterium *Synechococcus* sp. WH8102, a new model organism. *Aquat Microb Ecol* **35**: 17-29.
- Six C, Thomas JC, Garczarek L, Ostrowski M, Dufresne A, Blot N *et al.* (2007). Diversity and evolution of phycobilisomes in marine *Synechococcus* spp.: a comparative genomics study. *Genome Biol* **8**: R259.
- Sogin ML, Morrison HG, Huber JA, Welch DM, Huse SM, Neal PR *et al.* (2006). Microbial diversity in the deep sea and the underexplored "rare biosphere". *Proc Natl Acad Sci USA* **103**: 12115-12120.
- Sommer U. (1985). Competition between steady state and non-steady state competition: experiments with natural phytoplankton. *Limnol. Oceanogr.* **30**: 335-346.
- Sommer U. (1993). Phytoplankton competition in Plußsee: a field test of the resource-ratio hypothesis. *Limnol. Oceanogr.* **38**: 838-845.
- Stackebrandt E, Goebel BM. (1994). A place for DNA-DNA reassociation and 16S rRNA sequence analysis in the present species definition in bacteriology. *Int J Syst Bacteriol* **44**: 846-849.
- Stackebrandt E, Frederiksen W, Garrity GM, Grimont PAD, Kampf P, Maiden MCJ *et al.* (2002). Report of the ad hoc committee for the re-evaluation of the species definition in bacteriology. *Int J Syst Evol Microbiol* **52**: 1043-1047.
- Stal LJ, Staal M, Villbrandt M. (1999). Nutrient control of cyanobacterial blooms in the Baltic Sea. *Aquat Microb Ecol* **18**: 165-173.
- Stal LJ, Walsby AE. (2000). Photosynthesis and nitrogen fixation in a cyanobacterial bloom in the Baltic Sea. *Eur J Phycol* **35**: 97-108.
- Stal LJ, Albertano P, Bergman B, von Brockel K, Gallon JR, Hayes PK *et al.* (2003). BASIC: Baltic Sea cyanobacteria. An investigation of the structure and dynamics of water blooms of cyanobacteria in the Baltic Sea - responses to a changing environment. *Cont Shelf Res* **23**: 1695-1714.
- Staley JT, Konopka A. (1985). Measurement of insitu activities of nonphotosynthetic microorganisms in aquatic and terrestrial habitats. *Annu Rev Microbiol* **39**: 321-346.
- Staley JT. (2006). The bacterial species dilemma and the genomic-phylogenetic species concept. *Philos T Roy Soc B* **361**: 1899-1909.
- Stern A, Doron-Faigenboim A, Erez E, Martz E, Bacharach E, Pupko T. (2007). Selecton 2007: advanced models for detecting positive and purifying selection using a Bayesian inference approach. *Nucleic Acids Res* **35**: W506-W511.
- Stomp M, Huisman J, de Jongh F, Veraart AJ, Gerla D, Rijkeboer M *et al.* (2004). Adaptive divergence in pigment composition promotes phytoplankton biodiversity. *Nature* **432**: 104-107.
- Stomp M, Huisman J, Vörös L, Pick FR, Laamanen M, Haverkamp T, Stal LJ. (2007). Colourful coexistence of red and green picocyanobacteria in lakes and seas. *Ecol Lett* **10**: 290-298.
- Stomp M, Huisman J, Stal LJ, Matthijs HCP. (2007b). Colorful niches of phototrophic microorganisms shaped by vibrations of the water molecule. *ISME Journal* **1**: 271-282.

- Stomp M, van Dijk MA, van Overzee HMJ, Wortel M, Sigon CAM, Egas M *et al.* (in press). The time scale of phenotypic plasticity, and its impact on competition in fluctuating environments. *Am Nat.*
- Suikkanen S, Fistarol GO, Graneli E. (2005). Effects of cyanobacterial allelochemicals on a natural plankton community. *Mar Eco Prog Ser* **287**: 1-9.
- Swire J. (2007). Selection on synthesis cost affects interprotein amino acid usage in all three domains of life. *J Mol Evol* **64**: 558-571.
- Swofford DL. (2003). PAUP*. Phylogenetic Analysis Using Parsimony (*and other methods) Version 4. Sinauer Associates: Sunderland, Massachusetts.
- Tamura K, Nei M, Kumar S. (2004). Prospects for inferring very large phylogenies by using the neighbor-joining method. *Proc Natl Acad Sci USA* **101**: 11030-11035.
- Tamura K, Dudley J, Nei M, Kumar S. (2007). MEGA4: Molecular evolutionary genetics analysis (MEGA) software version 4.0. *Mol Biol Evol* **24**: 1596-1599.
- Taton A, Grubisic S, Brambilla E, De Wit R, Wilmotte A. (2003). Cyanobacterial diversity in natural and artificial microbial mats of Lake Fryxell (McMurdo dry valleys, Antarctica): A morphological and molecular approach. *Appl Environ Microbiol* **69**: 5157-5169.
- Terauchi K, Montgomery BL, Grossman AR, Lagarias JC, Kehoe DM. (2004). RcaE is a complementary chromatic adaptation photoreceptor required for green and red light responsiveness. *Mol Microbiol* **51**: 567-577.
- Thomas S, Gaiser EE, Tobias FA. (2006). Effects of shading on calcareous benthic periphyton in a short-hydroperiod oligotrophic wetland (Everglades, FL, USA). *Hydrobiologia* **569**: 209-221.
- Thompson JD, Higgins DG, Gibson TJ. (1994). Clustal-W - improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Res* **22**: 4673-4680.
- Thompson JR, Pacocha S, Pharino C, Klepac-Ceraj V, Hunt DE, Benoit J *et al.* (2005). Genotypic diversity within a natural coastal bacterioplankton population. *Science* **307**: 1311-1313.
- Tilman D. (1982). *Resource Competition and Community Structure*. Princeton Univ. Press, Princeton.
- Toledo G, Palenik B, Brahmsha B. (1999). Swimming marine *Synechococcus* strains with widely different photosynthetic pigment ratios from a monophyletic group. *Appl Environ Microbiol* **65**: 5247-5251.
- Torsvik V, Sorheim R, Goksoyr J. (1996). Total bacterial diversity in soil and sediment communities - A review. *J Ind Microbiol* **17**: 170-178.
- Tuomainen JM, Hietanen S, Kuparinen J, Martikainen PJ, Servomaa K. (2003). Baltic Sea cyanobacterial bloom contains denitrification and nitrification genes, but has negligible denitrification activity. *FEMS Microbiol Ecol* **45**: 83-96.
- Uku J, Bjork M, Bergman B, Diez B. (2007). Characterization and comparison of prokaryotic epiphytes associated with three east african seagrasses. *J Phycol* **43**: 768-779.
- van der Meer MTJ, Schouten S, Damste JSS, Ward DM. (2007). Impact of carbon metabolism on C-13 signatures of cyanobacteria and green non-sulfur-like bacteria inhabiting a microbial mat from an alkaline siliceous hot spring in Yellowstone National Park (USA). *Environ Microbiol* **9**: 482-491.
- van der Wielen P, Bolhuis H, Borin S, Daffonchio D, Corselli C, Giuliano L *et al.* (2005). The enigma of prokaryotic life in deep hypersaline anoxic basins. *Science* **307**: 121-123.

- Vasconcelos VM, Pereira E. (2001). Cyanobacteria diversity and toxicity in a wastewater treatment plant (Portugal). *Water Res* **35**: 1354-1357.
- Vassileva M, Torii K, Oshimoto M, Okamoto A, Agata N, Yamada K *et al.* (2006). Phylogenetic analysis of *Bacillus cereus* isolates from severe systemic infections using multilocus sequence typing scheme. *Microbiol Immunol* **50**: 743-749.
- Villena MJ, Romo S. (2003). Phytoplankton changes in a shallow Mediterranean lake (Albufera of Valencia, Spain) after sewage diversion. *Hydrobiologia* **506**: 281-287.
- Vis C, Hudon C, Carignan R. (2006). Influence of the vertical structure of macrophyte stands on epiphyte community metabolism. *Can J Fish Aquat Sci* **63**: 1014-1026.
- Visser PM, Ibelings BW, Mur LR. (1995). Autumnal sedimentation of *Microcystis* spp. as results of an increase in carbohydrate ballast at reduced temperature. *J Plankt Res* **17**: 919-933.
- Vives-Rego J, Lebaron P, Nebe-von Caron G. (2000). Current and future applications of flow cytometry in aquatic microbiology. *FEMS Microbiol. Reviews* **24**: 429-448.
- Vörös L, Callieri C, Balogh KV, Bertoni R. (1998). Freshwater picocyanobacteria along a trophic gradient and light quality range. *Hydrobiologia* **370**: 117-125.
- Walsby AE. (2005). Stratification by cyanobacteria in lakes: a dynamic buoyancy model indicates size limitations met by *Planktothrix rubescens* filaments. *New Phytol* **168**: 365-376.
- Ward DM, Weller R, Bateson MM. (1990). 16S rRNA sequences reveal numerous uncultured microorganisms in a natural community. *Nature* **345**: 63-65.
- Ward DM, Bateson MM, Ferris MJ, Kuhl M, Wieland A, Koeppl A *et al.* (2006). Cyanobacterial ecotypes in the microbial mat community of Mushroom Spring (Yellowstone National Park, Wyoming) as species-like units linking microbial community composition, structure and function. *Philos T Roy Soc B* **361**: 1997-2008.
- Ward DM. (2006). Microbial diversity in natural environments: focusing on fundamental questions. *Antonie van Leeuwenhoek* **90**: 309-324.
- Ward DM, Cohan FM, Bhaya D, Heidelberg JF, Kuhl M, Grossman A. (2008). Genomics, environmental genomics and the issue of microbial species. *Heredity* **100**: 207-219.
- Wayne LG, Brenner DJ, Colwell RR, Grimont PAD, Kandler O, Krichevsky, MI *et al.* (1987). Report of the ad-hoc-committee on reconciliation of approaches to bacterial systematics. *Int J Syst Bacteriol* **37**: 463-464.
- West NJ, Scanlan DJ. (1999). Niche-partitioning of *Prochlorococcus* populations in a stratified water column in the eastern North Atlantic Ocean. *Appl Environ Microbiol* **65**: 2585-2591.
- Whitaker RJ, Grogan DW, Taylor JW. (2003). Geographic barriers isolate endemic populations of hyperthermophilic archaea. *Science* **301**: 976-978.
- Wilhelm SW, Bullerjahn GS, Eldridge ML, Rinta-Kanto JM, Poorvin L, Bourbonniere RA. (2006). Seasonal hypoxia and the genetic diversity of prokaryote populations in the central basin hypolimnion of Lake Erie: evidence for abundant cyanobacteria and photosynthesis. *J Great Lakes Res* **32**: 657-671.
- Willame R, Boutte C, Grubisic S, Wilmotte A, Komarek J, Hoffmann L. (2006). Morphological and molecular characterization of planktonic cyanobacteria from Belgium and Luxembourg. *J Phycol* **42**: 1312-1332.

- Wilson JB, Spijkerman E, Huisman J. (2007). Is there really insufficient support for Tilman's R* Concept? A comment on Miller *et al.* *Am Nat* **169**: 700-706.
- Woese CR, Fox GE. (1977). Phylogenetic structure of the prokaryotic domain: the primary kingdoms. *Proc Natl Acad Sci USA* **74**: 5088-5090.
- Woese CR, Kandler O, Wheelis ML. (1990). Towards a natural system of organisms: proposal for the domains *Archaea*, *Bacteria*, and *Eucarya*. *Proc Natl Acad Sci USA* **87**: 4576-4579.
- Wood AM. (1985). Adaptation of photosynthetic apparatus of marine ultraphytoplankton to natural light fields. *Nature* **316**: 253-255.
- Wood AM, Horan PK, Muirhead K, Phinney DA, Yentsch CM, Waterbury JB. (1985). Discrimination between types of pigments in marine *Synechococcus* spp. by scanning spectroscopy, epifluorescence microscopy, and flow cytometry. *Limnol Oceanogr* **30**: 1303-1315.
- Wood AM, Phinney DA, Yentsch CS. (1998). Water column transparency and the distribution of spectrally distinct forms of phycoerythrin-containing organisms. *Mar Ecol-Prog Ser* **162**: 25-31.
- Worden AZ, Binder BJ. (2003). Application of dilution experiments for measuring growth and mortality rates among *Prochlorococcus* and *Synechococcus* populations in oligotrophic environments. *Aquat Microb Ecol* **30**: 159-174.
- Wright F. (1990). The effective number of codons used in a gene. *Gene* **87**: 23-29.
- Xia X, Xie Z. (2001). DAMBE: software package for data analysis in molecular biology and evolution. *J Hered* **92**: 371-373.
- Zaballos M, Lopez-Lopez A, Ovreas L, Bartual SG, D'Auria G, Alba JC *et al.* (2006). Comparison of prokaryotic diversity at offshore oceanic locations reveals a different microbiota in the Mediterranean Sea. *FEMS Microbiol Ecol* **56**: 389-405.
- Zani S, Mellon MT, Collier JL, Zehr JP. (2000). Expression of *nifH* genes in natural microbial assemblages in Lake George, New York, detected by reverse transcriptase PCR. *Appl Environ Microbiol* **66**: 3119-3124.
- Zeidner G, Preston CM, Delong EF, Massana R, Post AF, Scanlan DJ *et al.* (2003). Molecular diversity among marine picophytoplankton as revealed by *psbA* analyses. *Environ Microbiol* **5**: 212-216.
- Zengler K, Toledo G, Rappe M, Elkins J, Mathur EJ, Short JM, Keller M. (2002). Cultivating the uncultured. *Proc Natl Acad Sci USA* **99**: 15681-15686.
- Zhaxybayeva O, Gogarten JP, Charlebois RL, Doolittle WF, Papke RT. (2006). Phylogenetic analyses of cyanobacterial genomes: Quantification of horizontal gene transfer events. *Genome Res* **16**: 1099-1108.
- Zwart G, Kamst-van Agterveld MP, van der Werff-Staverman I, Hagen F, Hoogveld HL, Gons HJ. (2005). Molecular characterization of cyanobacterial diversity in a shallow eutrophic lake. *Environ Microbiol* **7**: 365-377.
- Zwirgmaier K, Heywood JL, Chamberlain K, Woodward EMS, Zubkov MV, Scanlan DJ. (2007). Basin-scale distribution patterns lineages in the Atlantic Ocean. *Environ Microbiol* **9**: 1278-1290.
- Zwirgmaier K, Jardillier L, Ostrowski M, Mazard S, Garczarek L, Vaultot D *et al.* (2008). Global phylogeography of marine *Synechococcus* and *Prochlorococcus* reveals a distinct partitioning of lineages among oceanic biomes. *Environ Microbiol* **10**: 147-161.