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CyanoNews

Updated 15 January 2003
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Plausibly Asked Questions (PAQs)

How can I most effectively use this newsletter? By treating what you read as the beginning, not the end of the discussion. If you have thoughts on the topic, click on the name of the contact person or contact *CyanoNews* (upper right corner of page). If you want to find out more, click on references that are sometimes embedded, or click on the contact person.

How current is the news in this newsletter? News is posted as it is received (dates of posting are noted in the Table of Contents). Every so often, the oldest items are archived. The current newsletter consists of several months of news.

How does it get to be current? By readers contributing news.

What could I possibly contribute? Funny you should ask. (click here)

How do I get a printed copy of the *CyanoNews*?*CyanoNews* was published as a printed newsletter for its first 13 volumes. Most back issues are still available. Starting with Volume 14, the newsletter has been constructed for viewing on the web and embraces the connectivity of that medium. You can use the capacity of your web browser to print out specific items of interest, but a printed version of the entire newsletter does not exist.

The page looks funny. How do I make the words bigger/smaller? You have control over this. If you're using Netscape 3.0, click on Options, General Preferences, Fonts, Choose Fonts (proportional), then play with the font size.

Do I have to plow through all these questions to get to the newsletter? No (but that was the last one anyway). Just click on Table of Contents here or at the top of the page.

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Bulletin Board

(15 January 2003)

Announcements: Miscellany of cyanobacteriological interest (last post 7 October 2002)

(see more, particularly regarding books, at CyanoSite)

Meetings: Various aggregates of cyanobacteriologists and others (last post 15 November 2002)

Positions Available: Job ads (last post 15 January 2003)

Transitions: The comings and goings of ourselves (last post 19 July 2002)

ANNOUNCEMENTS

If you encounter difficulties obtaining this newsletter, please let me know. Also, please pass on any suggestions you may have.

Cyanobacterial reference service to move to the web

(posted 7 October 2002)

For several years, visitors to *CyanoSite* have been able to download installments of *CyBib*, a collection of research articles and reviews focusing on cyanobacteria. Since the number of articles exceeds 12000, the files are of limited value without software that can read them and facilitate searches. Up until now, the responsibility has been on the user to find that software. Now, Mark Schneegurt, proprietor of *CyanoSite*, is developing an online search engine that can perform searches for the user on the spot. The database has also been considerably expanded to include many more articles before 1990.

A working prototype of the search engine now exists, and when the site is open to the public, the URL will appear in this newsletter.

Cyanobacteria in Symbiosis To Be Published Soon

(posted 26 January 2002)

Many of us have on our bookshelves the *Handbook of Symbiotic Cyanobacteria*, published in 1990 by CRC Press. The editor of that volume, Amar Rai, tells us that Kluwer Academicwill be publishing sometime this year a new volume, *Cyanobacteria in Symbiosis*, intended to update and extend the original work. There will be new chapters on algal symbioses, the evolution of symbiosis, cyanobiont diversity and the *Geosiphon-Nostoc* symbiosis.

Global Anti-GlnA, Anti-Rubisco, Anti-PsbA (D1) Antibodies Available

(posted 26 December 2001)

Polyclonal antibodies have been developed that recognize peptide targets found in all known GlnA proteins (glutamine synthetase), RbcL Type I (ribulose bis-phosphate carboxylase; rubisco), and PsbA/D1 (Photosystem II core protein). The antibodies are commercially available from AgriSera AB. Using antibodies with broad taxonomic ranges may facilitate tracking changes in photosynthesis and metabolism in a wide range of samples, including uncharacterized cyanobacteria and mixed phytoplankton samples. More global antibodies are under development including Anti-NirB (nitrite reductase) and Anti-NifH (nitrogenase).

> Contact: Joanna Porankiewicz-Asplund, AgriSera AB, Box 57, SE-911 21 Vännäs, Sweden. Phone: +46-(0)-935-33033; Fax:+46-(0)-935-33044; Email: Joanna@agrisera.se

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Monograph Describes Practical Application of Cyanobacteria

(posted 26 December 2001)

A new book, *Algal Biotechnology*, despite its name, devotes much of its 398 pages to cyanobacteria and their uses. The book (ISBN 8171322867) was written by PC Trevedi and published in 2001 by Pointer Publishers, Jaipur. It has several chapters on agricultural exploitation of cyanobacteria as well as problems in realizing their potential as food and feed. The book may be obtained from Books & Periodicals Agency
for US$56.25.

> Contact: Books & Periodicals Agency- B-1, Inder Puri, New Delhi-12, INDIA. Fax: (U.S. number)1-719-623-7004

MEETINGS

XIth International Symposium on Phototrophic Prokaryotes

(revised 19 October 2002)

The 2003 edition of the International Symposium on Phototrophic Prokaryotes will be held in Tokyo, August 24 through 29. This occasion marks the first time that the symposium will take place in Asia. The symposium will cover the usual wide range of topics, from biochemistry and molecular biology, through genomics, to ecology and applied aspects. An announcement of the symposium is available on-line, where it is also possible to preregister, insuring oneself of future notices. Deadline for registration is 15 May 2003, and deadline for application for financial support is 15 March 2003. The organizing committee can be contacted at:

> Ken-ichiro Takamiya, Department of Biological Sciences, Faculty of Bioscience and Biotechnology
> Tokyo Institute of Technology, Nagatsuta, Midoriku, Yokohama 226

JAPAN. E-MAIL:ispp2003@takamiya.bio.titech.ac.jp

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2004 Cyanobacterial Molecular Biology Workshop

(posted 15 November 2002)

After several meetings at the Asilomar Conference Center, the next (VIIIth) Cyanobacterial Molecular Biology Workshop will be held in the Montreal area as a satellite meeting to the 2004 Photosynthesis Congress. The dates are set for August 25 - 29, 2004 at the Hotel Le Chantecler in Ste. Adele, Quebec. The program will be developed starting this winter. In the meantime, for input and/or more information contact:

Rob Burnap, Oklahoma State University. E-MAIL: burnap@bmb fs1.biochem.okstate.edu
or George Bullerjahn, Bowling Green State University. E-MAIL: bullerj@bgnet.bgsu.edu

POSITIONS AVAILABLE

Position offered: **PhD Student** (posted 15 January 2003)

Contact: Sven Janson, Department of Biology and Environmental Science, University of Kalmar, Barlastgatan 1, S-391 82 Kalmar, Sweden Tel: +46 480 447310; Email: Sven.Janson@hik.se Internet:www.bom.hik.se/~njasv and www.bom.hik.se/plankton

Research: **Evolution of photosynthetic capability in dinoflagellates.** Dinoflagellates are unicellular protists that often gain their nutrients through phagocytosis, and to a large extent through photosynthesis. The dinoflagellate *Dinophysis norvegica* is the dominating dinoflagellate in the Baltic Sea during summer and is capable of both phagocytosis and photosynthesis. The plastid inside *D. norvegica*originates from a cryptophyte, another type of protist, but whether it is a permanent component of the cell or needs to be re-filled periodically is still an open question. The main focus within this project will be to study how species of *Dinophysis* obtain(ed) their plastids and how active they are. The source of the plastids and their activity will be examined using molecular biology methods. The project also includes tropical dinoflagellates that have conquered new plastids or contain symbiotic cyanobacteria.

Requirements:	Bachelors degree. Special merits are given for microbial ecology-, plant-, biochemical or molecular biological knowledge.
Start:	Available immediately. Open until a suitable candidate has been appointed.

Position offered:	**Post Doc** (posted 19 October 2002)
Contact:	Fevzi Daldal, University of Pennsylvania, Department of Biology and Johnson Research Foundation, 204 Mudd Building, Philadelphia PA 19104-6019, U.S.A. Tel: 215-898-4394; Fax: 215-898-8780; Email: fdaldal@sas.upenn.edu
Research:	Structure/function and biogenesis of cytochrome complexes in bacteria. For current examples of work, see: • Cytochrome *bc*1 complex structure and function [Darrouzet et al (2000) Proc Natl Acad Sci USA 97:4567-4572; Darrouzet et al (2001) Trends Biochem Sci 26:445-451]. • Cytochrome *cy* [Myllykallio et al (1999) Proc Natl Acad Sci USA 96: 4348-4353; Daldal et al (2001) J Bacteriol 183:2013-2024] • Cytochrome maturation and biogenesis [Koch et al (2000) J Mol Biol 297:49-65; Deshmukh et al (2000) Molec Microbiol 35:123-138]
Requirements:	Solid background and experience in any of the following areas: molecular genetics, protein biochemistry, or spectroscopy. A keen interest in interdisciplinary approaches.
Start:	Available immediately.
Salary:	Commensurate with experience, and negotiable. Positions are for several years.
Send:	CV, a brief description of previous research accomplishments and names or references.

Position offered:	**Post Doc** (posted 19 June 2002)
Contact:	Bridgette Barry, Dept. of Biochemistry, Molecular Biology, and Biophysics, 140 Gortner Laboratory, 1479 Gortner Ave., University of Minnesota, St. Paul, MN 55108, U.S.A. TEL:

1-612-624-6732; FAX: 1-612-625-5780;
EMAIL: Barry@Biosci.Cbs.UMn.Edu;
WEB:http://cbs.umn.edu/bmbb/faculty/Barry.B.A.html

Research: Study of the photosynthetic water-splitting reaction with time resolved FT-IR spectroscopy. The laboratory is equipped with an EPR spectrometer, two Nicolet FT-IR spectrometers, and a new Bruker 66v step scan/rapid scan FT-IR spectrometer, with time resolution in the nanosecond time regime (see http://biosci.cbs.umn.edu/BMBB/barrylab/).

Start: Summer 2002

Send: CV, summary of previous research experience, and the names of three references

TRANSITIONS

Four cyanobacteriologists working at University of Stockholm in the laboratory of Bergitta Bergman recently defended their PhD theses:
PERNILLA LUNDGREN defended her thesis on January 25, 2002, concerned the characterization of nitrogen fixation and the molecular phylogeny of marine non-heterocystous cyanobacteria. She is rewarding herself with a long holiday traveling in Asia. (19/vii/02)
CHARLES LUGOMELA completed his thesis on cyanobacterial diversity and productivity in coastal areas of Zanzibar. Charles continues to work on Tanzanian cyanobacteria at University of Dar-es-Salam, Tanzania. (19/vii/02)
JENNY DEGERHOLM presented her thesis on Ecophysiological Characteristics of the Baltic Sea N_2-fixing cyanobacteria *Aphanizomenon* and *Nodularia*. (19/vii/02)
ANTON LIAIMER successfully defended his thesis May 31, 2002, on communication between cyanobacteria and plants. He will be moving from Birgitta's lab down the hall where he'll be a post-doc in the lab of Stanislaw Karpinski studying mostly *Arabidopsis* but perhaps continuing his work on cyanobacterial symbioses on the side.

Department of Botany, Stockholm University, SE-106 91 Stockholm, SWEDEN. EMAIL:Anton.Liaimer@Botan.Su.Se

PER PAULSRUD passed his PhD thesis defense on October, 2001. The thesis described the diversity and specificity within the interaction between *Nostoc* and fungi to form lichen. He has since continued work in the lab of Peter Lindblad and obtained a certificate enabling him to teach in high school.

Department of Physiological Botany, Evolutionary Biology Centre, Uppsala University, Villavägen 6, SE-752 36 Uppsala, SWEDEN. EMAIL: Per.Paulsrud@Fysbot.Uu.Se

ADRIAN CLARKE moved in 2001 from University of Umeå to University of Gothenberg in south western Sweden. The chair position he accepted was part of the establishment of a new plant molecular biology department at the Botanical Institute.

Botanical Institute, Göteborg University, Box 461, 405 30 Göteborg, SWEDEN. TEL:46-31-7732502; FAX:46-31-7732626; EMAIL: Adrian.Clarke@botinst.gu.se

FRANCOISE JOSET has retired from her position at University of Marseille, after a career of increasing our understanding of areas including carbon uptake and salt stress. She also managed to find time to write what has been a standard text in bacterial genetics. She plans to reinvent her life, rediscovering paths left unattended owing to the pressures of the moment. Cyanobacteria will still grow in Marseille, as her former lab is now inhabited by another cyanobacteriologist, Cheng-Cai Zhang. (26/xii/01)

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Boris V. Gromov

Boris Gromov died 28 August 2001 after a long career primarily at Leningrad State University/St. Petersburg State University. He had broad interests, contributing to the understanding of cyanobacterial ultrastructure, toxins and other bioactive products, cyanophages. His legacy includes the CALU collection of algae, which includes hundreds of cyanobacteria and the many cyanobacteriologists who developed under his tutelage.

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ALEX GLAZER was elected this past spring to the U.S. National Academy of Sciences. Alex has devoted much of his professional life to understanding the function of phycobilisomes. (11/ix/01)

MICHELLE WOOD has spent most of her career trying to understand the community structure of marine cyanobacteria. Now she turns her attention to the community of phycologists, assuming the post of President of the Phycology Society of America for the year 2001. (7/ix/01)

JEFF ELHAI has moved from U. Richmond across town to Virginia Commonwealth University to work in the lab of Jerry Peters (not much more than 100 km from Washington, D.C., for those passing through). He'll continue to work on the regulation of heterocyst differentiation. (31/viii/01)

Dept. of Biology, Virginia Commonwealth University, 1000 W. Cary St., Richmond, VA 23284 U.S.A. E-MAIL: ElhaiJ@VCU.Edu; TEL: 1-804-828-0794; FAX: 1-804-828-0503; WEB:http://www.people.vcu.edu/~elhaij

OLAF NEUSCHAEFER-RUBE, formerly at U. Konstanz, has moved to Oslo to work with Hans Utkilen on the regulation of microcystin biosynthesis.

Folkehelsa, National Institute of Public Health, Dep. of environmental medicine, Geitmyrsveien 75, P.O.Boks 4404 Nydalen, N-0403 Oslo, Norge. E-MAIL:Olaf.Neuschaefer.Rube@folkehelsa.no; TEL: (+47) 22 04 23 70;

FAX: (+47) 22 04 26 86

News

(updated 7 October 2002)

News Items

Genome Update

It takes a community to annotate a genome: Annotation of cyanobacterial genomes by us all (7 October 2002)

Free software available to display cyanobacterial genomic sequences (7 October 2002)

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Growth of unicellular cyanobacteria in absence of oxygen (posted 26 December 2001)

Looking at home for extraterrestrials (Antarctic Astrobiology Project) (posted 25 October 2001)

Unicellular cyanobacteria and N_2 fixation in the ocean (posted 17 October 2001)

Hydrotactic-like movement by desert cyanobacteria (posted 17 October 2001)

Anabaena genome sequence completed (revised 12 October 2001)

Meeting Reports

5th European Workshop on the Molecular Biology of Cyanobacteria (2002) (posted 18 July 2002)

(Note: Meeting reports, by necessity, cannot be exhaustive. To retain one's sanity, a reporter must put aside the natural inclination to pay respect to everyone's contribution and instead focus on a few presentations of personal interest. Many other presentations deserving of notice are therefore left unmentioned.)

It takes a community to annotate a genome

(7 October 2002)

The initial outcome of a genome sequencing project is a very large number of G, A, T, and C's. Someone has to go through millions of nucleotides and figure out what it all means. The initial pass, by virtual necessity is done by computer, through automated open reading frame detection and provisional assignment of function by sequence similarity to previously annotated open reading frames. For a significant length of time, this is all the annotation there is, and the errors in annotation are sometimes frightful. Often a group of humans check the provisional annotation, but it is unreasonable to expect any limited number of humans to be sufficiently learned about all aspects of cyanobacterial physiology and molecular biology to rid the provisional annotation of all its errors. The group that stands the best chance to do the job is cyanobacteriologists as a whole, and Minoru Kanehisa (Kyoto U.), Masahiko Ikeuchi (U. Tokyo), and Tatsuo Omata (U. Nagoya) have resolved to enlist that group.

They have developed an interface to enable annotators to add their bit of wisdom to the genes of the completed genomes of three cyanobacteria: *Synechocystis* PCC 6803, *Anabaena* PCC 7120, and *Thermosynechococcus elongatus* BP-1. The sites focusing on each of the three are called SYORF, ANORF and TEORF, respectively. Annotators are free to work on any of the genes in any of the genomes, so genes may acquire several layers of knowledge from different annotators. So, apart from improving the quality of the annotation, the sites promise to provide the cyanobacteriological community with a valuable resource, an encyclopedia of cyanobacterial genes.

Anyone can see the fruits of this labor by going to the GenomeNet Community Databases web site, clicking on your favorite organism, and logging in as *guest* with a password of*guest*.Those wishing to join the effort should click on *Guidelines* at the top of the page for a link to the system administrator and other instructions.

Free software available to display cyanobacterial genomic sequences

(7 October 2002)

A program, *OrfText*, was developed out of desperation in response to the absence of any way to display the sequences of genomes in such a way that helps a human make sense out of them. It is very easy to access and download sequences of specific genes, but there is no obvious way to download, say, an entire operon and make readily visible where one gene ends and the next begins. *OrfText* was designed to fit that need.

Typical screen of *OrfText*

The program facilitate navigating through the replicons of finished sequences and contigs of unfinished sequences. Clicking on the name of an open reading frame brings up another screen with information including the names of orthologs in other cyanobacteria.

One can block out segments of the sequence (or select an open reading frame as a block) and invert or translate it, then save it to a file.

At present, *OrfText* runs only under DOS (within Windows), though there are plans to port it to the web.

The program is freely downloaded by going to http://www.people.vcu.edu/~elhaij/software/orftext/

Synechococcus PCC 7942 sequencing project tries novel approach

(7 October 2002)

Sequencing projects generally adopt a shotgun approach, sequencing fragments at random and piecing them together to form an increasingly complete whole. This leads to rapid accumulation of sequence but provides no direct help for the ultimate task of assessing the function of genes. Susan Golden has adopted a different approach with *Synechococcus* PCC 7942, focusing on specific segments of the genome at a time and determining function as the sequence is also determined. The strain is perhaps the premier organism for understanding the molecular basis of circadian rhythm.

The idea centers on the ability of Mu phage to hop randomly in vitro into DNA. DNA sequence is determined from the site of insertion outwards but in parallel, the mutant DNA is used to transform *Synechoccus*, producing a mutant whose circadian phenotype is related to the Mu-disrupted gene. Progress is considerably slower than with shotgun sequencing, but the genes identified by sequence are matched to phenotypes. At present, somewhere between 10% and 20% of the total genome has been sequenced in this way, and roughly 240 kb of chromosomal sequence has been deposited fully annotated in GenBank, plus two endogenous plasmids pANL and pANS.

Progress on the sequencing end will soon pick up, as Joint Genomes Institute has agreed to perform rapid sequencing of the genome.

You can follow progress in both sequence and functional annotation and also get a visual tutorial on the protocols used by going to the *Synechococcus* PCC 7942 web page.

Genome of thermophile *Thermosynechococcus elongotus* completely sequenced

(7 October 2002)

The thermophile *Thermosynechococcus elongatus* BP-1 has joined the ranks of cyanobacteria with completed genome sequences. It is the third cyanobacterial genome completed by theKazusa DNA Research Institute, (which has also completed the genomes of *Synechocystis* PCC 6803 and *Nostoc* PCC 7120). With the finished genomes of *Prochlorococcus marinus*MED4 and MIT9313, the number of completed cyanobacterial genomes has now swelled to 5 (see progress report on cyanobacterial genome projects).

The size of the circular chromosome of 2,593,857 nucleotides and no other replicons were found. This genome size is similar to that reported for *Synechococcus* WH8102, but the *T. elongatus* genome has several unusual features. First, the genome is relatively deficient in fatty acid desaturases. Whilc *Synechocystis* PCC 6803 possesses four types of desaturases --*desA*, *desB*, *desC*, and *desD* -- and both *Nostoc* PCC 7120 and *Nostoc punctiforme* possess the first three, *T. elongatus* has only *desC*. This and a relatively high number of heat-shock proteins is consistent with the cyanobacterium's high temperature life style.

A second unusual feature is the presence of 28 copies of group II introns in the *T. elongatus* genome. Group I introns are well known in cyanobacteria and and chloroplasts, lying within the $tRNA^{Leu}$ gene, but this may be the first reported instance of self-splicing group II introns.

A description of the genome has been published [Nakamura et al (2002) DNA Research 9:123-130].

Cyanobacterial Genome Projects

(updated 28 September 2002)

The world stood at attention as the news broke that the human genome had been sequenced. But, hey, we have sequences too! In fact, a cyanobacterium, *Synechocystis* PCC 6803, was amongst the first organisms fully sequenced, and there's more coming down the cyanobacterial pipe. So -- hello world! -- here's what we have in genome projects. See also Masahiko Ikeuchi's Genome Projects of Cyanobacteria site for more information on the strains.

Unicellular cyanobacteria

***Gloeobacter violaceus* PCC 7421:** 4.6 Mb. Finishing as of August 2002. By Kazusa DNA Research Institute. Contact: Satoshi Tabata

***Microcystis aeruginosa*:** 4.8 Mb. In progress as of December 2001. By Institut Pasteur, Paris. Contact: Nicole Tandeau de Marsac

***Prochlorococcus marinus* MED4**: 1.66 Mb, completed 2001. By Joint Genome Institute. Contact: Penny Chisholm

***Prochlorococcus marinus* MIT9313**: 2.4 Mb, completed 2001. By Joint Genome Institute. Contact: Penny Chisholm

***Prochlorococcus marinus* SS120:** 1.8 Mb, 8x coverage as of December 2001. By Genoscope. Contact: Frédéric Partensky and Daniel Vaulot.

***Synechococcus* PCC 6301 (*Anacystis nidulans*):** No information as of December 2001. By the Gene Research Center at Nagoya University. Contact: Mamoru Sugita

***Synechococcus* PCC 7002:** 6x coverage as of October 2001. By Beijing University. Contact: Jindong Zhao

***Synechococcus* PCC 7942:** Being annotated and deposited cosmid by cosmid. At least 8 cosmids and two endogenous plasmids sequenced and annotated by September 2002. Function approached by mutagenesis of each orf. Project at Texas A&M University but moving to Joint Genome Institute. Contact: Susan Golden

***Synechococcus* WH8102**: 2.4, completed 2001. By Joint Genome Institute. Contacts: Bianca Brahamsha, Brian Palenik, and John Waterbury

***Synechocystis* PCC 6803**: 3.6 Mb, complete, completed 1996, last modified Dec 1999, reannotated 2002. By Kazusa DNA Research Institute. Contact: Satoshi Tabata. Community annotation project at ANORF (enter as *guest*, password also *guest*). Contact Tatsuo Omata.

***Thermosynechococcus elongatus* BP1:** 2.6 Mb, completed 2002. By Kazusa DNA Research Institute. Contact: Satoshi Tabata. Community annotation project at TEORF (enter as*guest*, password also *guest*). Contact Tatsuo Omata.

Filamentous cyanobacteria

***Arthrospira (Spirulina) platensis*:** Finishing data collection as of January 2001. By Human Genome Center, Beijing.Contact: Cheng-Cai Zhang

***Trichodesmium erythraeum*:** 6.5 Mb, 1107 contigs as of September 2002. By Joint Genome Institute. Contacts: John Waterbury and Eric Webb.

Heterocystous cyanobacteria

***Anabaena* PCC 7120**: 6.4 Mb plus 800 Kb in six plasmids, completed 2001. By Kazusa DNA Research Institute. Contact: Satoshi Tabata. Community annotation project at ANORF(enter as *guest*, password also *guest*). Contact Tatsuo Omata.

***Nostoc punctiforme* ATCC 29133**: ~9 Mb, 662 contigs as of June 2000. By Joint Genome Institute. Contact: Jack Meeks

Most of the sites offer BLAST searches of the genome, either the DNA sequence or translation of it. You may download the entire available sequence or (in some cases) selected parts of it. The *Synechocystis* and *Anabaena* sites provide a graphical map of the genomes and their predicted genes.

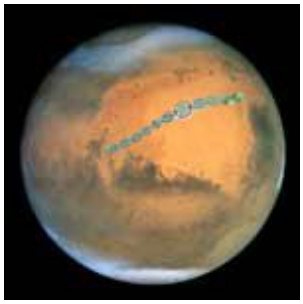
Growth of unicellular cyanobacteria in absence of oxygen

(posted 26 December 2001)

Daniel Emlyn-Jones (Australian National University) tells us that he recently observed that whereas the glucose tolerant *Synechocystis* PCC 6803 can grow normally in the complete absence of exogenous oxygen, bubbled with 5% nitrogen 95% carbon dioxide, *Synechococcus* PCC 7942 cannot grow at all under those conditions.

Looking at home for extraterrestrials

(Posted 25 October 2001)



Is there life on Mars? You'd think that to find out you'll have to go there and take a look. But if you can't wait for Martian coach fares to drop to reasonable levels, there is a second choice. David Wynn-Williams (British Antarctic Survey) tells us that he and his collaborators are approaching the question of extraterrestrial life by studying the persistence of cyanobacteria and other photosynthetic bacteria in our own backyard.

The Antarctic presents some of the same challenges a microbe might have faced during Martian history: extreme cold, high UV radiation, and scarcity of water. The British Antarctic Survey and its collaborators are using a battery of tools – spectroscopy, microscopy, and chemical analysis – to understand the extreme microenvironments inhabited by cyanobacteria and the organisms' responses to them.

The results of their studies may enable them to assess the degree to which Antarctic microhabitats model conditions that prevailed on Mars and to develop methods that may be used in recognizing the conditions for life on Mars and beyond.

Click here for more on Antarctic Astrobiology Project of the British Antarctic Survey.

Unicellular cyanobacteria and N_2 fixation in the ocean

Nitrogen is often the limiting nutrient in the ocean, and so it is of vital interest to determine the degree to which biological nitrogen fixation takes place and what bacteria are responsible. For many years, the prime suspect has been the nonheterocystous, filamentous cyanobacterium *Trichodesmium*, but recent evidence indicates that the abundance of the cyanobacterium is not sufficient to account for observed levels of N_2 fixation. Jonathan Zehr (U. California at Santa Cruz) and others now report that we need to look beyond *Trichodesmium*, demonstrating that highly abundant unicellular cyanobacterium also fix N_2.

Zehr et al [Nature (2001) 412:635-638; comment 412:593-595] used RT-PCR with universal *nifH* primers to measure the amount of *nif* transcripts in ocean samples taken at various times and filtered to remove *Trichodesmium*. For samples taken at a depth of 25 m, *nif* expression was high during at night and low during the day, while with samples from 50 m and 100 m, the pattern of expression was reversed. Nitrogenase expression in *Trichodesmium* is controlled by circadian rhythm, so that levels are high during the day [Chen et al J Bacteriol (1998) 180:3598-3605]. Sequences of most of the RT-PCR products proved to be similar to those from cultivated unicellular cyanobacteria, while the remainder showed similarity to *nif* genes from proteobacteria.

It is difficult to assess the amount of N_2 fixed by unicellular cyanobacteria as compared to *Trichodesmium*, and it remains to be shown whether N_2-fixing unicellular strains have a range beyond the subtropical North Pacific Ocean station where the samples were taken. Nonetheless, the now proven existence of a new source of biological N_2 fixation in the open ocean should be enough to send modelers scurrying back to their computers.

Hydrotactic-like movement by desert cyanobacteria

It is not surprising to encounter heterotrophic bacteria that move towards organic nutrients or phototrophic bacteria that move towards light, but what about bacteria that seek a chemical even more essential to life – water? In very dry environments, an organism that is able to follow a receding pocket of water would possess an enormous advantage. Does this ability exist?

Ferran Garcia-Pichel (Arizona State University) and Olivier Pringault (Universite Bourdeaux) recently reported the behavior of cyanobacteria that appear to have just this ability [Nature (2001) 413:380-381]. Monitoring the vertical movement of an *Oscillatoria* population within soil samples from an arid region of Spain, they found that filaments accumulated at the surface over the course of minutes when dry soil was wetted and, conversely, filaments disappeared when the wet soil was allowed to dry. Movement was not towards light, as it occurred upon wetting equally in the dark as in the light, nor was it the result of a purely physical force (e.g. surface tension), as it was blocked by inhibitors of metabolism. Rather, the movement appears to be towards either wetness itself or towards some environmental condition associated with it, e.g. salinity or the resumed metabolic activity of other microorganisms in the soil.

As with any tactic response, there is the intriguing question as to how a microorganism can sense what is the proper direction in which to head. Chemical or activity gradients over the length of a single cell must be infinitesimal – can a filamentous cyanobacterium compare environmental conditions present at one end of its length with that present at the other? Alternatively, does the filament compare conditions as they change over time, continuing its path if conditions improve but changing directions if they don't?

Genome of *Anabaena* PCC 7120 completed

(updated 12 October 2001)

The first complete genomic sequence of a filamentous cyanobacterium has been completed by the Kazusa DNA Research Institute. The heterocystous *Anabaena* PCC 7120 has a single chromosome of 6,413,773 base pairs, plus six plasmids ranging from 5,586 bp to 408,103 bp. The new web site, similar in format to the *Synechocystis* web site, permits searches by gene category, keyword, or sequence similarity.

Ecophysiological characteristics of the Baltic Sea N_2-fixing cyanobacteria *Aphanizomenon* and *Nodularia*

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During three years, 1998-2000, the significance of N_2 fixation was studied in coastal and offshore waters of the northern Baltic proper. This is the first seasonal study on N_2 fixation rates in the Baltic Sea using the sensitive ^{15}N tracer technique. Rates of N_2 fixation in the size fraction >20 µm followed the seasonal and annual fluctuations of cyanobacterial biomass, primarily *Aphanizomenon*. Light affected the vertical distribution of cyanobacterial biomass and rates of N_2 fixation, with highest rates at the surface. The daily pattern of N_2 fixation activities was also affected by irradiance, with peak activities around noon. Mean N_2 fixation rate at night were 37 % of the average daytime rate.

In 1999, the filamentous cyanobacteria *Aphanizomenon* and *Nodularia* were studied along a north-south transect in the Baltic proper. Spatial variations in the phosphate uptake kinetics may be due to adaptations to prevailing conditions. High concentrations of alkaline phosphatases (APases) were detected in association with P-sufficient cyanobacteria, suggesting that*Aphanizomenon* and *Nodularia* may be of high importance for the regeneration of phosphorus in the surface waters of the Baltic Sea.

In 1999 and 2000, *Aphanizomenon* colonies were collected in May, July & September in coastal surface waters of the northern Baltic proper. High P-incorporation rates in spring were followed by low rates in summer and autumn, thereby suggesting P-sufficiency during their biomass peak in summer. Hence, results indicated that the cyanobacteria could provide P for themselves in both open and near-shore waters. However, the size-fractionated seawater samples indicated P-deficiency in the >20 µm size fraction. This may be due to the presence of detrital material in the samples. Also cellular N contents suggested N-sufficiency throughout summer. Positive correlations between cellular Fe:C ratios and specific growth rates of the cyanobacteria, along with seasonal drops in Fe:C coinciding with the biomass peaks of the N_2-fixing cyanobacteria, indicated Fe-limited cyanobacteria. Further, a positive relationship between the Fe:C and P:C ratios suggested some kind of interrelation between dissolved P and Fe in the Baltic Sea.

Additional studies of *Aphanizomenon* and *Nodularia* under controlled laboratory conditions indicated a higher sensitivity to low ambient P levels by *Aphanizomenon* in comparison with*Nodularia*. However, high growth rates during P-replete conditions indicated that *Aphanizomenon* may be a stronger competitor in waters characterised by nutrient pulses, such as upwelling areas. Total annual N_2 fixation in the Himmerfjärden bay was estimated to 41, 24 & 68 tons N yr^{-1} for 1998, 1999 and 2000, respectively. These results suggest that the N input from N_2 fixation does not compensate for the reduced N discharge in the nearby sewage treatment plant. Total annual N_2 fixation was estimated for the whole Baltic proper. In 1998, 1999 and 2000, total N input from

N_2 fixation were 94 000, 78 000 and 27 000 tons N yr^{-1}, respectively. Hence, biological N_2 fixation may be the third largest source of N input to the Baltic proper, after river and land run-off and atmospheric depositions.

Molecular Communication and Responses in *Nostoc* - Plant Symbioses

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Diazotrophic heterocystous cyanobacteria of the genus *Nostoc* enter into nitrogen-fixing symbioses with a number of plants. During the initial steps of the infection process, liverwort*Blasia pusila* and *Gunnera* spp. induce hormogonia (motile filaments) formation in *Nostoc*, thus facilitating the infection. In this thesis we used subtractive RNA/DNA hybridisation to study differential gene expression in *Nostoc* in response to the hormogonia inducing mucilage, secreted by *Gunnera* symbiotic organs, the stem glands. Another approach employed was two dimensional protein gel electrophoresis of protein extracts from *Nostoc*, forming hormogonia in response to the fresh medium, *Blasia* exudates and mucilage from *Gunnera*. The set of proteins upregulated upon either of treatments was the same, with prolonged time of expression in *Gunnera* treated cultures. The identified hormogonia induction related genes/proteins in *Nostoc* may be divided in following groups: *Stress related*: low pH indueced gene *hieC* (homologous to *lpiA* from *Sinorhizobium meliloti*), a GTP cyclohydrolase I related protein, universal stress protein A (UspA); *Proteins earlier assigned a function in nitrogen fixation and heterocyst formation control*: NtcA - global nitrogen fixation regulator, undecaprenyl-phosphate galactosephosphotransferase involved inlipopolysaccharide biosynthesis, and a polyketide synthase; *Hormogonia specific proteins*: structural gas vesicle proteins; *Extracellular and outer-membrane*: *hieB*, encoding a protein related to hemolysin type proteins and an S-layer associated multidomain endoglucanase; *Low molecular weight proteins with unassigned function*: *hieA* from *nostoc* sp. PCC 9229, and an unidentified 7 kDa protein from *N. punctiforme* PCC 73102.

For the first time, we show that a vast range of cyanobacteria of all morphological types, including the majority of symbiotic isolates, is capable of synthesis and release of the plant hormone indole-3-acetic acid (IAA). In several *Nostoc* strains IAA biosynthesis is tryptophan dependent and is regulated by IAA precursors, anthranilate and tryptophan. An existence of a pathway via indole-3-pyruvic acid in some *Nostoc* is proposed based on the cyanobacterial genome analyses.

The roles of the novel hormogonia differentiation related host plant-induced genes/proteins and cyanobacterial IAA in establishment of symbioses with plants are discussed.

Manuscripts on which thesis is based

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Liaimer A, Sergeeva E, Bergman B (in preparation). Indole-3-acetic acid in cyanobacateria of the genus *Nostoc*: Regulation of biosynthesis and influence on growth and cell differentiation.

Cyanobacterial diversity and productivity in coastal areas of Zanzibar, Tanzania

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Tropical marine ecosystems are in general highly oligotrophic habitats. Some free-living and symbiotic prokaryotic organisms, such as cyanobacteria, often common in these habitats can utilize atmospheric nitrogen to meet their nitrogen requirements. Being photosynthetic, cyanobacteria also play an important role in oceanic production and sequestration of atmospheric carbon dioxide to the ocean interior. Consequently, attempts are now being made to fully assess the source (diversity) and rates of N_2 and CO_2 fixation in the world's oceans and to determine their regulation at molecular, cellular, ecosystem and global levels. The present investigation was aimed at determining cyanobacterial diversity in coastal areas of the western Indian Ocean around the Island of Zanzibar, and to assess their ecological significance with regard to their role in delivering carbon and 'new' nitrogen to this ecosystem.

A total of 50 cyanobacterial species from within 21 genera were encountered and described morphologically. Most of these are new records from the area. Typical habitats were plankton, as free living and symbiotic, and benthic, as epiphytes and microbial mats. The filamentous non-heterocystous forms were most common comprising 64% of the species described. Heterocystous forms constituted 24% and unicellular cyanobacteria 12%. Cyanobacterial spatial and temporal distribution regulated by environmental parameters such as water temperature and nutrient concentration was apparent and discussed.

Eleven potentially diazotrophic cyanobacteria were found to be capable of N_2-fixation, some of which were often abundant in their habitat. The non-heterocystous cyanobacterium*Lyngbya majuscula*, common in the area, was shown to fix nitrogen only during the night as nitrogenase, present in all cells, was degraded during the day. The most common planktonic cyanobacterium, *Trichodesmium* was estimated to fix up to 42.7 mmol N $m^{-3}y^{-1}$ while contributing between 0.03% and 20% of total CO2 fixation in the surface waters during the dry and rainy seasons, respectively. Unicellular, picocyanobacteria were estimated to contribute on average 16% of the total plankton primary production and between 37 to 74% of the carbon needed by heterotrophic nanoflagellates during the rainy season. Photosynthetic activity in submerged cyanobacteria dominated biofilms showed light adaptation at different depths and quickly responded to changes in irradiance. Preliminary observations at the study site suggested CO_2 fixation rates of 0.14 kg C m^{-2} y^{-1}.

The data presented here suggest higher cyanobacterial diversity in the area. Many cyanobacteria that are widespread and abundant are also capable of a diazotrophic life. It is proposed that cyanobacteria play a key role in cycling of C and N in coastal areas of Tanzania.

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Marine Non-Heterocystous Cyanobacteria:
Diazotrophic Characterization & Molecular Phylogeny
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As it is difficult to reconcile concomitant oxygenic photosynthesis and oxygen labile nitrogen fixation cyanobacteria have evolved different adaptation strategies to overcome this anomaly. A confinement of nitrogenase into a special micro-aerobic cell is seen for heterocystous species. Cyanobacteria lacking this cell type confide in other behavioral strategies. For these, the most common approach is to separate nitrogen fixation and photosynthesis in time. As photosynthesis by necessity must occur during the light phase, nitrogen fixation accordingly takes place during the dark phase.
The only exception to the above strategies is *Trichodesmium*. This marine cyanobacterium fixes nitrogen aerobically only during the light phase. Nitrogenase is confined to a specific cell type, diazocytes, arranged consecutively and constituting 7-20% of all cells.
In the present study a method was developed which enabled detection of these nitrogenase-containing diazocytes using an epi-fluorescence microscope. This enabled screening studies of their distribution in a large number of trichomes and within colonies of natural and cultured *Trichodesmium*. Groups of diazocytes were found randomly spread over colonies, and the trichomes could contain more than one group of these zones. The unique nitrogen fixation behavior of Trichodesmium was also examined in relation to the photochemical quantum yield [variable fluorescence/maximal fluorescence (Fv/Fm)], oxygen production, and C uptake. This unveiled that *Trichodesmium* not only practices a spatial separation of the two incompatible processes, but also a temporal separation between N_2 fixation and photosynthesis during the photo phase. Nitrogen fixation peaked around midday, and varied inversely with oxygen evolution, ^{14}C-uptake and Fv/Fm. When examining Fv/Fm two- dimensionally, regions with lower yields were seen along trichomes, and a larger proportion of the trichomes displayed lower Fv/Fm at the peak of nitrogen fixation.
Prior to this study, this nitrogen fixation strategy was exclusively found in Trichodesmium. However, another marine cyanobacterium, *Katagnymene*, was here discovered to share the same localization of nitrogenase into diazocytes and daytime nitrogen fixation. Though, phylogenetic analyses performed revealed that the two species of *Katagnymene* were in fact one, and had such a high sequence similarity to *Trichodesmium* that they were re-affiliated to this genus. Also, a novel species of *Trichodesmium* was found, assigned *T. aureum* sp. nov. The nitrogen fixation behavior and phylogeny of yet another common marine cyanobacterium, *Lyngbya majuscula* was examined. Like *Trichodesmium*, *L. majuscula* has previously been reported to fix nitrogen during the photo phase. Our data show that under natural conditions nitrogenase activity is only observed during the dark phase and that is the case for the nitrogenase enzyme as well, and nitrogenase was detected in all cells. This thesis provides novel insights into the nitrogen fixing behavior of *Trichodesmium*, and unveils

novel members of the genus, including those previously characterized as the genus *Katagnymene*. It also reveals that *Lyngbya majuscula* does not share this same nitrogen fixing behavior, but fixes nitrogen at night as many other non-heterocystous cyanobacteria. Hence, *Trichodesmium* is still the only non-heterocystous genus capable of aerobic daytime nitrogen fixation.

Publicly defended January 25th 10:00 in the lecture hall at the Department of Botany, Stockholm University

Faculty opponent: Professor John R. Gallon, School of Biological Sciences, University of Wales Swansea, Singleton Park, Swansea, SA2 8PP, U.K.

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The *Nostoc* Symbiont of Lichens: Diversity, Specificity, and Cellular Modifications

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Cyanobacteria belonging to the genus *Nostoc* have the capacity to form symbiotic associations with a wide range of organisms. Diversity, specificity and cellular modifications of the symbiosis between *Nostoc* and fungi in the formation of lichens were investigated in this thesis.

The use of the $tRNA^{Leu}$UAA intron as a genetic marker for the subgeneric identification of *Nostoc* in complex field material was developed. Lichens belonging to the genera *Peltigera*and *Nephroma* show limited variability in their *Nostoc* symbionts. The *in situ* symbiont consists of a single strain rather than a community of different *Nostocs*, and single thalli consistently contained the same symbiont. Patterns in symbiont identity were found in geographically remote populations, and the lichen species, rather than growth locality, was shown to be important for the identity of the *Nostoc* symbiont. Examination of a *P. aphthosa* photosymbiodeme revealed that one *Nostoc* has the capacity to perform the physiological roles found in both bipartite and tripartite lichens. The symbiotic association between bryophytes and *Nostoc* on the other hand exhibited a much greater variation of *Nostoc* symbionts.

Evolutionary patterns in the $tRNA^{Leu}$UAA intron were analyzed, and it was shown that sequence variation was caused by several processes other than random mutations. Such evolutionary processes in genetic markers are crucial to consider, especially if phylogenetic reconstructions are attempted.

Protein profiles of symbiotic and free-living *Nostoc* were analyzed using 2-dimensional gel electrophoresis. One of the major proteins in the extracts from freshly isolated symbionts was partially sequenced and shown to contain a fasciclin domain. The corresponding ORF in *N. punctiforme* was homologous to symbiotically induced genes found in different symbiotic systems.

This thesis gives new perspectives on lichens and provides a platform for further examinations using tools provided by modern biology.

Manuscripts on which thesis is based

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Meeting Report

5th European Workshop on the Molecular Biology of Cyanobacteria

At 2:00 PM, June 9, 2002, cyanobacteriologists gathered in the auditoreum of the Royal Swedish Academy of Sciences hushed to hear an important announcement. If the date were somewhat different, the announcement could have been of a new Nobel Prize winner. As it happened, Birgitta Bergman announced the opening of the 5th Eurepean Workshop on the Molecular Biology of Cyanobacteria, scarcely of lesser importance considering the presentations that would follow.

For the next four days participants learned of advances in the cyanobacteriological world in the areas of aquatic systems, photosynthesis and respiration, symbiosis and plastid evolution, metabolism and stress, and functional genomics. While it is not possible to cover the full breadth of the meeting, some participants have offered reminisces that may serve to give readers a flavor of what went on. Please feel invited to respond or supplement the accounts given below.

What cyanobacteria do for plants
Stressed-out cyanos

5th European Workshop on the Molecular Biology of Cyanobacteria (2002)
Meeting Report

What cyanobacteria do for plants

by Elinor Thompson (Photosynthesis Research Group, University College London)

All the members of our research group who went to Stockholm enjoyed the city as the location for the 5th European Workshop on the Molecular Biology of Cyanobacteria. The weather was perfect and we took every opportunity to walk around the city or, even better, get on a boat. But work wasn't too bad either: the conference venue was very smart and there were some excellent talks. Highlights were the presentations by William Martin – one of the most charismatic as well as one of the most interesting speakers – and by David Adams. Although this was a conference for cyanobacteriologists, similarities and interactions between plant and cyanobacterial proteins were discussed right from the beginning, with Jim Barber's description of antenna systems. But after the football results on the final day of the conference, John Allen summarised, '*Anabaena* three–*Arabidopsis* nil'.

David Adams (University of Leeds, UK) gave a summary of the many symbiotic associations between cyanobacteria and eukaryotes. It was illuminating to discover how many of these involved *Nostoc* – the importance of which was a recurring theme during the meeting. For those of us working mostly on *Synechocystis* it is always interesting to hear about its (equally) important relatives. After an entertaining video clip of the response of hormogonia to plant chemoattractant, David summarised some of his lab's work on mutants in hormogonium formation, one of a number of presentations highlighting aspects of protein expression control in cyanobacteria.

Kept in suspense until the very end of the talk by William Martin (Heinrich-Heine University, Düsseldorf, Germany), we finally found out that the answer was 18% – that is the proportion of genes in *Arabidopsis* that appear to have originated in the cyanobacterial precursor of the chloroplast. Of nearly 9400 proteins from the plant that gave a hit in a sequence database, about 1700 (most of them chromosomally encoded) appear to have a cyanobacterial origin. All functional categories are represented by these proteins: as is well-known, the chloroplast only managed to hang onto the bulk of one group, the photosynthesis and respiration genes. Even this is very variable, of course. This presentation also included a summary of the difference in the extent of the reduction of the chloroplast genome. Whereas the *Porphyra* chloroplast encodes about 200 proteins, *Euglena* appears to have retained genes for only 58. Once again, *Nostoc* appeared as a very likely close relative of the much-discussed chloroplast ancestor. Lateral gene transfer as ever complicates the picture, however. Interestingly, the similarity between Gram-positive bacterial genes and plant genes may be due to the similarity between cyanobacteria and the Gram-positive bacteria. The final figure for plant genes originating in cyanobacteria may rise again.

Christiane Funk (Umeå University, Sweden) and Iwona Adamska (Stockholm University, Sweden) are working on members of the Deg serine protease family, a

group of proteins that are present in both chloroplasts and cyanobacteria. Even though the genes for Clp proteases are apparently the only ones retained in plant chloroplasts, other chromosomally-encoded proteases have very important roles in maintenance of the photosynthetic apparatus. DegP2 is one of the *Arabidopsis* proteases implicated in the repair of the D1 protein of photosystem II after photoinhibitory damage in vitro. This presentation, however, showed that DegP2's closest homologue in *Synechocystis* (HtrA) appears not to have the same role. Deletion mutants of htrA, hhoA (degQ equivalent) and hhoB (degS) in fact demonstrated a role for HtrA in heat shock, and only under oxidative stress. It was the hhoA protease mutant that impeded D1 repair in *Synechocystis* after high light, although the most dramatic effect was only after heat shock. All of the protease genes showed light-activated transcription but, again in contrast to the plant versions, the level of transcription was not affected by heat shock in the cyanobacterium. Clearly, the roles of the numerous chloroplast and cyanobacterial proteases still require clarification.

5th European Workshop on the Molecular Biology of Cyanobacteria (2002)
Meeting Report

Stressed-out cyanos

by Caroline Aspinwall (University College London)

Last summer many of us were interested by the publication of Nature papers describing a photosystem I antenna ring formed under conditions of iron limitation. Jim Barber (Imperial College, London, UK) described in the opening lecture a series of events that lead to this remarkable structure. Iron limitation causes reduced synthesis of iron-rich photosystem I. In response to iron limitation, up-regulation of *isiA* and *isiB* genes leads to the synthesis of CP43' (IsiA) protein and flavodoxin, respectively (flavodoxin functions as an alternative electron acceptor in place of ferredoxin). A ring of 18 chlorophyll-binding CP43' proteins around photosystem I dramatically raises its light-absorbing capacity. Sucrose density gradient separation of photosystem I from iron-limited *Synechocystis* cells yields a heavy band consisting of CP43'-photosystem I supercomplexes. Analysis of the supercomplexes revealed the existence of chlorophyll molecules bound to some accessory photosystem I subunits such as PsaJ. These may act as a bridge for excitation energy between the antenna ring and the photosystem. The *pcb* genes of Prochlorophytes are homologous to *isiA*. The supercomplex band was observed in gradients from *Prochlorococcus marinus* SS120, a deep-sea strain. It resembled the*Synechocystis* antenna but contained both chlorophyll a and b. A ring was sometimes found around photosystem II dimers in *Prochlorococcus* species; full 14 subunit rings were rarely observed but asymmetric 11 subunit rings were often encountered. Rings were also found in *Acaryochloris marinus* containing chlorophyll d. In the lab, cyanobacteria grow contentedly in media with iron supplements and use phycobilisomes for light-harvesting. These studies show that 'out in the wild', where iron limitation is likely to be a common challenge, these CP43' rings may be the norm. In his talk on marine cyanobacteria, Wolfgang Hess (Humboldt University, Berlin, Germany) mentioned the loss of phycobilisome-related genes from oceanic *Prochlorococcus*, and perhaps this is because the CP43' antenna is more useful in these environments. A poster by Ulrike Geiß (University of Greifswald, Germany) described profiling of *isiA* gene expression to look directly at iron starvation in aquatic habitats. The gene was detected in various estuary samples and three gene families were described.

Those groups working on iron limitation were probably interested in B. Gemmer's poster (University of Greifswald, Germany), which outlined the difficulties in producing thoroughly iron-depleted media. They explained their use of the siderophore desferrioxamine-B (DFOB). An iron stress response (monitored using GFP-tagged *isiAB* promoter in *Synechocystis*) was seen when DFOB was added even to iron-rich BG11 medium.

Salt stress was another hot topic, with Martin Hagemann (University Rostock, Germany) describing it as "a paradigm for acclimation to environmental stresses".

When salt concentrations are elevated, cells face multiple stresses – ionic, osmotic, oxidative etc. Cyanobacteria fight back with both specific and general responses. Cells accumulate compatible solutes such as glucosylglycerol. Transport mechanisms, energy production and other systems are affected. Of the salt-induced proteins identified, most were general stress proteins (chaperones, repair systems etc). Salt sensing is not well understood. Functional genomics revealed the involvement of alternative sigma factor SigF. DNA microarrays identified several histidine kinases involved in sensing and gene activation.

N. Yeremenko and V. Krasikov (University of Amsterdam, the Netherlands) described the use of DNA arrays to investigate patterns of gene expression under different growth conditions. They use an optimised mRNA purification and hybridisation to an array in which all *Synechocystis* genes are represented. Stress conditions investigated included phosphate or nitrate limitation and various levels of salt stress. Specific and general responses were detected.

Despite all the stress-related presentations and posters, the only problems faced by this meeting's attendees were heat stress and football deprivation. Fortunately, all five workshop sessions benefited from interesting enthusiastic speakers who easily held our attention even in the unanticipated sleepy warm weather! Our excellent hosts provided world cup updates where necessary. This enjoyable workshop was a huge success and those of us who were lucky enough to spend a little time exploring Stockholm have arrived home completely stress-free.

How to contribute

(to bottom line)

You'd be amazed how much of what you consider common knowledge is new and provocative to others. What you dismiss as matters of only local interest may well be vital to someone else far away. Think about contributing the following:

News from the bench: Found something interesting? Let us know! There are few predators in our field, and the best way to keep it that way is to cast your vote for the open exchange of ideas. And what better way to solicit helpful comments from your colleagues?

Summary of your thesis: As sad as it may seem, very few people will ever read the magnum opus over which you've shed blood. Tell us your story, and use this as an opportunity to join the active discussion in our community.

Announcements/requests: Looking for a strain? Just published a book? Have a post-doc position available? Let it be known!

Change of life: You may think that your change of jobs or upcoming visit to another lab is of interest only to yourself. Wrong. We want to know, too, partly because it makes our world more interesting and partly because if we only knew you were there we would... who knows?

Summary of a meeting: You just came back from an interesting meeting. Think of all of us who *couldn't* go! Don't wait to be invited, send us your thoughts on a few of the most interesting presentations (an excellent way to preserve what you gained). What if someone else does the same? Not likely, but if so, the meeting probably deserves the attention, and both offerings will be sewn together to form a pleasing whole.

Notice of a future meeting: I hardly ever get any announcements. If notice of an upcoming meeting is going to appear in this newsletter, it's because someone like you thought to pass on the news.

Worried about your English? Don't! The *CyanoNews* staff stands ready to help your ideas find the expression they deserve.

Bottom line: ***Send news!*** (click here)