MEETING REPORT

Thermophiles 2009*

The International Conference on Thermophiles Research was attended by 376 scientists from 18 countries all over the world. It was inaugurated with a plenary lecture delivered by Xian-En Zhang, Ministry of Science and Technology of the People's Republic of China on 'Perspectives on life sciences and biotechnology in China'. The keynote lecture was delivered by Don Cowan from South Africa who expressed that electrostatic interactions and hydrogen bonds are responsible for thermostability of enzymes. His work on increasing the volume of the active site cavity through site-directed mutagenesis in the enzyme nitrile hydratase of *Geobacillus pallidus* was highly appreciated. Todd Lowe of USA talked on *Pyrobaculum* and proposed it as a new model system by comparing its genome sequence, RNA profiling as well as DNA microarray expression studies. He also said that the genetic basis for the diversity of metabolism of *Pyrobaculum* is still unexplored due to lack of comparative models. The most interesting lecture of the session was by Derek Litthauer (South Africa), who spoke about his work on genome sequence of *Thermus scotoductus* SA01 and said that the involvement of new c-type cytochromes in metal reduction of ThsSA01 is entirely different from cytochromes present in other metal reducing organisms like *Geobacillus sulfurreducens* and *Shewanella oneidensis*.

The session 'Evolution and the Origin of Life' comprised four lectures. J. Tze-Fei Wong (Hong Kong) gave an elaborate talk on identification of last universal common ancestor (LUCA), last eukaryotic common ancestor (LECA) and last bacterial common ancestor (LBACA) by tRNA sequence analysis. He further mentioned that a LUCA is closest to the archaeon *Methanopyrus*, a LECA proximal to the eukaryote *Plasmodium* and derived from an archaeon close to *Ferroplasma* and a LBACA proximal to the bacterium *Thermotoga* and derived from an archaeon close to *Aeropyrum*. Mark Young (Thermal Biology Institute, USA) shared his studies on paired cellular-viral metagenomics that can help in understanding diversity in viruses from high temperature environments.

During the session on diversity and ecology of thermophiles, Japanese microbiologist Ken Takai overviewed hydrothermal fluid chemistry and chemolithoautotrophic microbial communities in deep-sea hydrothermal fields. Juergen Wiegel (University of Georgia, USA) spoke on the role of multiple ion pumps and Na^+-coupled processes for survival of *Natranaerobius thermophilus* under the combined stress conditions of alkaline pH, elevated temperature and high salt concentrations. Nils-Kare Birkeland (University of Bergen, Norway) reported a novel thermo-acidophilic methanotroph from an acidic hotspring in Kamchatka and said that it is a unique kind of study in the field of thermophilic research and will be explored for its commercial applications. Stephen Brian Pointing (School of Biological Sciences, University of Hong Kong) presented his work on the expression profile of key metabolic genes involved in oxygenic photosynthesis (*cbbL*), anoxygenic photosynthesis (*pufM*) and nitrogen fixation (*nifH*) from different layers of thermophilic cyanobacterial mat.

The session on genetic mechanisms of thermophiles included seven lectures. Yoshizumi Ishino (Kyushu University, Japan) emphasized on development of new technology of gene amplification by understanding the ring structure of PCNA of hyperthermophilic archaeon *Pyrococcus furiosus* and the strength of the ion-pair network between the subunit-interfaces of PCNA and its role in flexibility of PCNA structure. Zvi Kelman (USA) spoke on minichromosome maintenance (MCM) proteins as functional homologue of replicative DNA helicases in archaea and eukarya and revealed the active hexameric ring structure of MCM protein of *Methanothermobacter thermautotrophicus*.

Michael Thomm (Regensburg University, Germany) presented the most interesting talk of the session; he talked about the function of B-finger and linker region of transcription factor B that remains conserved evolutionarily from archaea to eukaryote. A novel mechanism of transcription regulation in archaea was explained by Nan Peng and his group (University of Copenhagen, Denmark). They reported the interaction between P_{araS}- BRE and the ara-box element and suggested that the interaction of DNA binding protein with the upstream promoter element is essential not only to recruit TFB but also to form transcription initiation complex.

During the environmental adaptations session, Xiuzhu Dong, Roy Daniel, Frank Robb and Debananda S. Ningthoujam talked on various adaptation machineries of thermophiles. Roy Daniel (New Zealand) presented his studies on the active sites of enzyme that dictate the effect of temperature on enzyme activity; his work was considered useful for studies on evolution of temperature linked enzyme adaptations.

Frank T. Robb (University of Maryland Institute, USA) compared the genome sequence of thermophilic hydrogenogenic carboxydotroph *Thermosinus carboxydivorans* with the model *Carboxydothermus hydrogenoformans* and found the involvement of molecular chaperones particularly an archaeal-like Hsp60 which allows these thermophilic hydrogenogens to grow in an extreme niche.

In the physiology and metabolism session, Michael W. W. Adams (USA) delivered a talk on identification of metalloproteins in anaerobic marine archaeon *Pyrococcus furiosus* model system. He identified 200 metal peaks, out of which few were assigned to known metalloproteins, few peaks included metals uranium, lead, molybdenum, manganese, germanium, vanadium, iron, nickel, cobalt, tungsten and zinc.

Haruyuki Atomi (Japan) focused his lecture on coenzymeA biosynthesis pathway in *Thermococcus kodakaraensis* and explained about novel archaea-specific enzymes pantoate kinase and

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phosphopantothenate synthetase, which replace the function of the classical pantothenate synthetase and pantothenate kinase. Arnold J. M. Driessen and his group (University of Groningen, Netherlands) presented an interesting talk in this session. He said archaea possess some unique cell surface structures like flagella and pili though they appear to be similar to their bacterial counterparts but possess significant differences and archaeal twists. He also said that some archaeal structures such as cannulae and hami appear to be unique to the archaeal domain and identified few bindosome in the cell surface of *Sulfolobus solfataricus*.

Kesen Ma (Canada) talked on alcohol dehydrogenase of *Thermatoga hypogea* and characterization of the purified enzyme. The enzyme is a homodimer with a subunit molecular weight of 40 ± 1 kDa, half-life of about 10 h at 70°C and its catalytic activity increases along with the rise of temperature up to 95°C. He also spoke on sequence analysis of iron-containing alcohol dehydrogenase from hyperthermophilic bacteria and archaea and found that they were clearly separate groups, indicating the divergence of the two types of enzymes.

William B. Whitman reported that F_{420}-reducing hydrogenase Fru was a component of the major pathway of H_2 production in *Methanococcus maripaludis* and it was found that the mutants possessing deletions of the gene encoding the F_{420} dependent methylene – H_4 MTP dehydrogenase or the H_2-forming methylene-H_4 MTP dehydrogenase also possess reduced activity that suggest these proteins were components of second pathway of H_2 production.

Six lectures were delivered during the session on mobile genetic elements and genetic tools. Qunxin (Denmark) explained the archaeal DNA replication and repair genes, i.e. *sis-cdc6* encoding the putative archaeal replication initiators, *SisR-pcna* encoding the heterotrimeric PCNA sliding clamps and the genes encoding DNA polymerases absolutely required for the viability of *Sulfolobus islandicus* archaeal organism.

The application session included lectures by Jennifer Littlechild, Zhengqiang Jiang, Peter Schonheit and Bing Tang on the use of thermophilic enzymes for industrial applications. Jenny Littlechild (University of Exeter, UK) discussed various thermophilic enzymes developed by the Exeter Biocatalysis Centre that are already used commercially such as L-aminoacylase from *Thermococcus litoralis* for the resolution of amino acids and amino acid analogues, gamma lactamase from *Sulfolobus solfataricus* for the production of optically pure gamma lactam – the building block for anti-viral carbocyclic nucleotides and alcohol dehydrogenase from *Aeropyrum pernix* for the production of optically pure alcohols. Enzymes in development include transaminase, dehalogenase from *Sulfolobus* and an aldo-keto reductase from *Thermatoga* species.

A lecture on recombinant xylanase which effectively hydrolyses birchwood and beechwood xylan to produce xylobiose and xylotriose, proven as a potential enzyme for paper, timber and cotton industry was delivered by Zhengqiang Jiang (China). Peter Schonheit (Germany) spoke on ADP forming acetyl-CoA synthetase, a novel glycolytic and acetate forming enzyme from an anaerobic hyperthermophilic archaea *Pyrococcus furiosus*.

Microbial diversity and whole cell protein analysis of few microbes from hot water springs of Orissa was described by Amrita Panda and Satpal Singh Bisht (Roland Institute of Pharmaceutical Sciences, Berhampur, India).

Overall, the conference was a good platform for scientists from various parts of the world to learn and present their investigations. The conference ended with a lead lecture delivered by Eric J. Mathur (Synthetic Genomics, Inc, USA) on 21st Century Trends in Molecular Ecology and Biotechnology of Extremophiles. He presented a review on modern approaches such as advances and refinements in molecular phylogenetics, novel microbial cultivation methods, high throughput genomics, functional genomics and metagenomic technologies in the context of extremophile research.

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