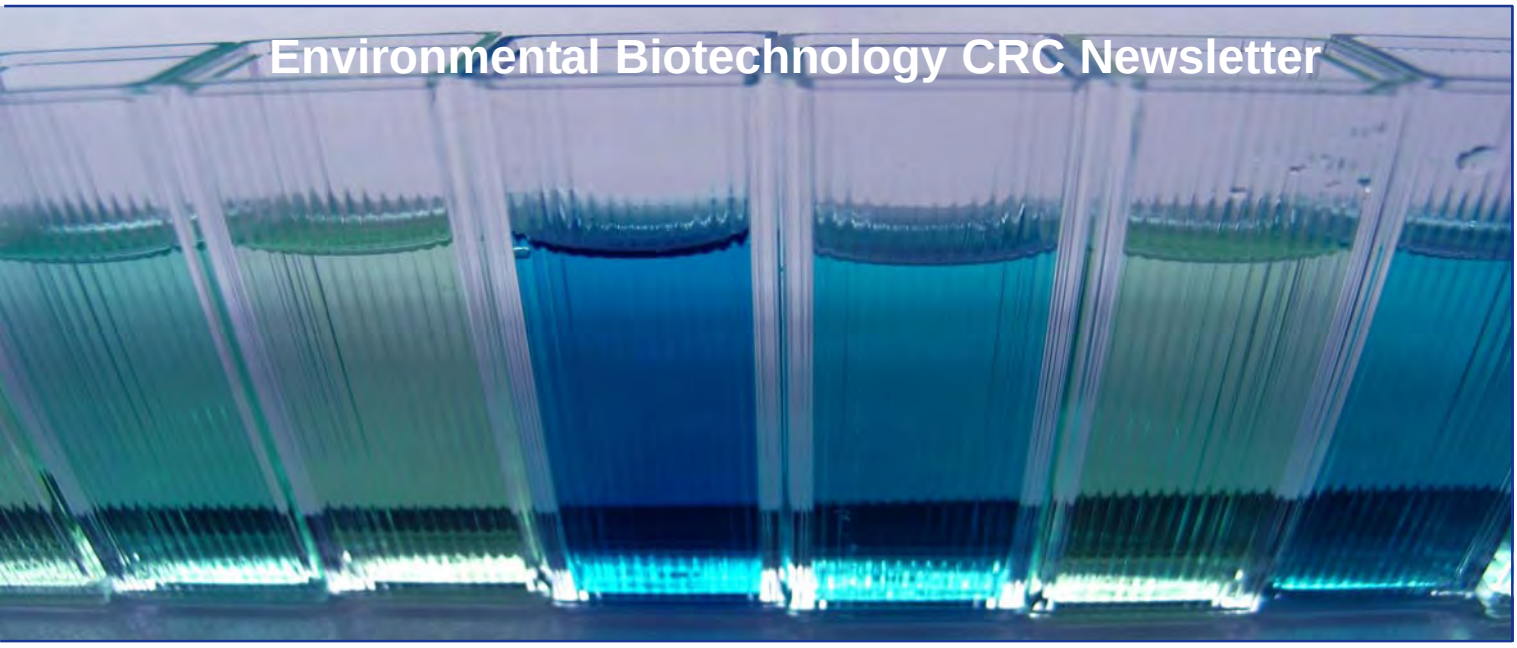
Enviro BioText



Environmental Biotechnology CRC Newsletter

Edition 4 January 2006

Biotechnology benefiting the Environment

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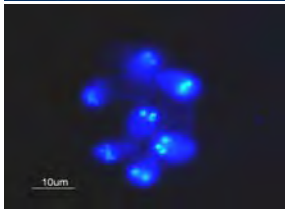
Protozoa - these organisms graze on biofilms



Giardia stained for easy identification

Profile

EBCRC PhD Student
Rob Steuart

Rob was born and raised in the hills outside of Perth in Western Australia. He completed his BSc at Curtin University in 2003 majoring in Molecular Genetics.

His honours year involved looking at the phylogenetic analysis of root nodule bacteria from Western Australian Legumes.

Rob started his PhD at Murdoch University at the end of 2004 as part of EBCRC's Pathogen Detection project - looking at proteomics of *Giardia duodenalis.*

This involves a lot of the molecular work he was used to but has also included acquiring new skills, such as the correct procedure for obtaining a faecal sample from a calf.

Rob finds the project demanding but interesting and he continually bores his wife Kathy with exciting stories of his latest 2D gel image or another interesting fact he has learnt about *Giardia*.

Rob still lives in Kalamunda in the Perth hills with his wife Kathy. He spends most of his spare time at home with his puppy Dory, a Doberman Mastiff cross, and his cat Bella, one of a litter of feral cats that he and Kathy hand-reared.

Editorial

Dr. Sandra Hall
EBCRC Education & Training Coordinator

Meeting the needs of the biotech revolution

Biotechnology is not a fad. It is on the way to becoming a wide-reaching and integral part of the world economy.

One particular area - biofuels - is contributing significantly to the move away from international dependence on oil.

Bananas, palm oil, sugar cane and even household garbage will soon be providing fuel for construction, mining and general transport here in Australia.

Leading energy analysts Burrill & Co. have said that biofuels will soon be a vital source of energy in the growing economies of Asia.

Yet the nascent biofuels industry, like many biotech sectors, has a significant problem - a major shortage of graduates in science and engineering.

Likewise, Australia's ability to capitalise on its early start in the new research sectors of environmental and industrial biotechnology is hindered by a lack of skilled researchers.

Like many biotech sectors, we are losing researchers overseas – to higher paid positions and better-funded facilities.

Uniquely environmental biotechnology loses researchers at the graduate level to the more popular and well-known science disciplines.

Education & Training - a strategic output

EBCRC now has 24 students in postgraduate positions, but has places for 50. EBCRC's industry partners have more jobs than the CRC has scholars graduating.

If we can produce the scientists and engineers that will form part of the vanguard of the new biotechnology sector, we will have provided this sector with valuable resources for its future.

Training scientists for the future

EBCRC's education and training programme will ensure that the Australian environmental biotechnology industry is provided with the necessary skilled people to drive the research into the future.

Our goal is to create a pool of skilled practitioners including post-doctoral researchers that can work with industry and create new directions.

An integrated education programme

The EBCRC provides scholarships to post-graduate (PhD and Masters) and undergraduate (Honours and Vacation) students to develop research expertise across the full range of the centre's research capability.

Post-doctoral fellowships are also offered to attract appropriately skilled, high quality researchers, especially expatriates, as well as high calibre graduates from the PhD program.

As a former CRC student, I am aware of the value in completing postgraduate studies in the CRC environment.

A comprehensive education and training programme has been developed for the EBCRC that will deliver a large number of young researchers with unique interdisciplinary skills to Australian industries.

For more information on EBCRC's Education and Training Programme, or details about scholarship opportunities, please look on our website: www.ebcrc.com.au, or contact Sandra: s.hall@ebcrc.com.au

Commercialisation & IP: looking ahead

By Keith Steele
EBCRC Deputy Director

As the CRC approaches its third year review, we are re-evaluating the focus for commercial activities for the second half of the CRC's life.

A challenging question is how can we increase and accelerate commercially beneficial outcomes for the EBCRC *itself*, for its researchers and its members? Four areas have been identified that provide opportunities for commercial outcomes:

1. Biosensors

The EBCRC will expand its expertise and research activity in the monitoring and detection of environmental pathogens to the development of real-time biosensors. This is a difficult task and not currently addressed by any existing sensing technologies.

2. Bioproducts

The opportunity is to improve biofuel production efficiency and minimise waste products. EBCRC has an outstanding knowledge of microbial population dynamics that we should be exploiting commercially. Four areas of opportunity will be investigated: Biodiesel, Bioethanol, BioHydrogen and Biogas.

3. Biofilms

The aim is to develop an intellectual property portfolio focused on the utilisation, control and removal of biofilms utilising environmentally appropriate biotechnological solutions.

We have made a good start in this area with a provisional patent.

4. Bioremediation

The objective is to develop a suite of "generic" remedial organisms and environmentally appropriate chemicals that may be applied to contaminated sites.

The key will be to identify significant common contaminants affecting land and water globally and then to focus research and commercial efforts on these.

The commercial team is undertaking an in-depth analysis of markets, technologies, products, competitors, and commercial opportunities in each of the above areas.

When completed, it is proposed that this should guide the development of new EBCRC research projects.

New Project for the New Year

A Molecular Toolbox

A new EBCRC project has started which will examine the molecular based platform technologies of the EBCRC, in combination with already available analytical tools, to assess and control full-scale and laboratory scale biofilms.

The project, supported by industry partner Ecowise Environmental, aims to address three of the EBCRC's objectives, namely: to rapidly detect bacteria and other microorganisms, control and manage biological processes, and to restore the environment.

PhD Student Zoe Moore

The project will:

- optimise enabling technologies developed within the EBCRC to provide rapid, useful, flexible and affordable solutions to industry
- demonstrate novel biocontrol methods for managing biofilms in the water industry
- integrate research tools through the study of parallel lab-scale and full-scale systems and spanning physical, chemical and microbiological investigations
- develop asset operating tables and regimes based on scientific input to support risk management decision making
- produce skilled professionals required by the environmental biotechnology industry by providing career development for employees and students.

Profile

EBCRC Industry Partner
ORT

Organic Resource Technologies Limited (ORT) is an ASX listed company that supplies DiCOM® solid waste processing plants.

The patented DiCOM® process is a novel method for treating the organic municipal solid waste.

The process is self-sustaining, as biological heat production is harnessed to achieve operating temperature, with the biogas produced providing an excess of energy.

The centrepiece of the technology is the anaerobic thermophilic treatment of solid waste producing sustainable energy as a by-product. This process has now been tested successfully at pilot scale.

ORT's partnership with EBCRC focuses on developing an in-depth understanding of the microbial ecology of the three main stages of the DiCOM® process.

ORT positions itself at the forefront of the waste management services industry, pioneering a new approach to solving global solid waste problems. For more information, go to: www.ort .com.au

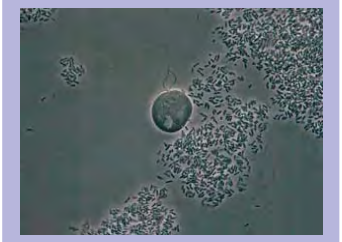
ORT's Research Facility in Jandakot, Perth

Nitric Oxide found to stimulate cell death in biofilms

EBCRC researchers have discovered that low levels of Nitric Oxide (NO) stimulate the rapid break-up of pesky biofilms

Photo - GAP EnviroMicrobial

Biofilms in water pipes can harbour disease-causing bacteria and increase corrosion



Protozoan grazing on biofilm organisms

Organisms clump together in microcolonies then disperse when these biofilms reach a mature stage.

Biofilms are groups of organised bacteria that build complex structures to protect themselves from attack. They are reservoirs for diseases in water systems and cause fouling and corrosion in water, sewage and oil pipes.

These problems lead to significant increases in costs for many industries, including oil, marine and water and sewage companies. Costs to industry for removing biofilms runs into billions of dollars annually.

There are 20,000 km of water pipes in Sydney alone

One of the main problems with controlling biofilms is that they are highly resistant to conventional treatments such as biocides and antibiotics. These methods tend to be expensive, inefficient and not sustainable - high concentrations of anti-microbial compounds are toxic to the environment.

Biofilms are multicellular systems whose behavioural traits are emerging as novel and exciting targets for biotechnologies.

Three ways of controlling biofilms are being examined by the EBCRC:

Programmed Cell Death

Recent research has shown that mature stage biofilms start programmed cell-death which assists in organismdispersal and the formation of new colonies.

EBCRC researchers based at the University of NSW have discovered that nitric oxide (NO) triggers this programmed cell death and dispersal.

This has been shown with model biofilm forming organisms as well as mixed natural communities. The dispersed bacteria then have increased sensitivity to antimicrobials. EBCRC's first patent application was submitted on the nitric oxide work.

Cell-to-cell signalling

It has been found that organisms that make up biofilms communicate with each other to assist the formation of biofilms. The EBCRC is taking advantage of the role of cell-to-cell signalling events in biofilms for preventing as well as fostering biofilm formation.

For example, suspended biofilms are required in wastewater treatment systems.

Protozoan Grazing

Protozoans, such as amoeba and ciliates, feed on bacteria and are in fact one of the major mortality factors of bacteria in many systems.

The EBCRC is examining the feeding patterns and food webs of protozoa as well as how bacteria protect themselves from protozoan predators.

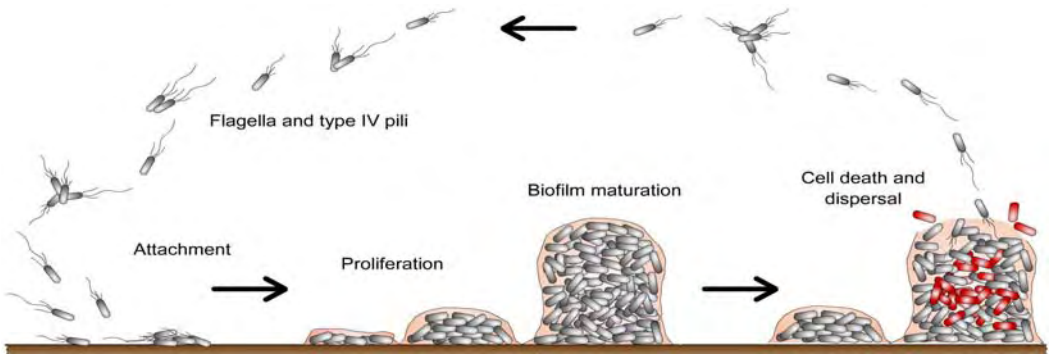
Work to date has shown that bacterial biofilms very effectively defend themselves against grazing protozoa.

Both the structural arrangements of biofilms and the biofilm specific production of inhibitors account for this defence. The combined effect of biofilm modifying treatments and protozoan grazing are predicted to allow for bioilm control in many industrial and other systems.

Biofilms can be a problem in any industrial process where fluids are in contact with surfaces.

The technology being developed by the EBCRC can be applied broadly in many industries where persistent biofilm growth is a problem.

Further collaboration may also allow for the development of this technology in application areas outside the immediate focus of the EBCRC, such as the health industry.



Getting more goodness from compost

Advanced biotechnologies are allowing us to further investigate how the microorganisms involved in composting processes work.

The EBCRC, together with industry partner Organic Resource Technologies (ORT) and Murdoch University, is working on a $1.3m project that will enhance a process that can convert large amounts of organic waste to compost more efficiently than ever before.

The patented composting process is called DiCOM®, and was developed by ORT (see industry profile on page 3) to deal with Municipal Solid Waste (MSW).

Getting the mix of compost right has been a matter of trial and error for centuries. Farmers and gardeners have tested different mixes of to get right balance without fully knowing what the micro-organisms do.

Actually understanding what roles the different organisms play in the degradation of waste could make this a better-controlled biological process.

We are trying to better understand the role composting organisms play

The EBCRC will also determine whether the process can be applied to not only MSW but also farming, agriculture and other organic waste streams.

There is evidence that the DiCOM® process produces a compost with superior qualities. Initial plant growth tests on the compost produced showed potential for improved root development.

The DiCOM® process operates within specially designed sealed tanks that allow anaerobic digestion as well as composting to occur without handling, odour emission or waste effluent production.

The compost produced would be suitable for agricultural and parklands use.

In the process, air is pumped into a tank for five days (aerobic phase). The airflow is then stopped so bacteria can work in an oxygen free environment for the next seven days (anaerobic phase). Air is pumped in again during the last seven days to produce garden-quality compost.

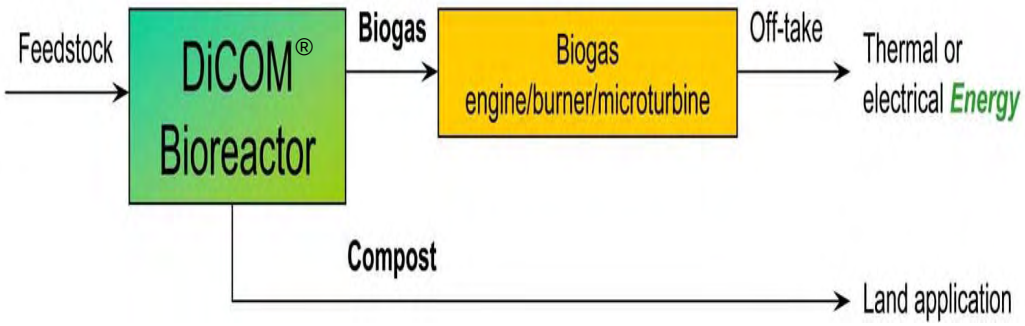
Each tank is able to take the organic fraction from around 1000 tonnes of MSW every 3 weeks.

In traditional composting, some methane - a greenhouse gas - is released as an undesired by-product. The ability to capture the methane as a biofuel during the anaerobic stage of the DiCOM® process is another attractive component of the project.

Methane can be collected and used to generate electricity

More effective harnessing of the energy contained within the waste as methane gas is one factor that is believed to make the final product more stable and hence suitable for agricultural uses.

In addition, maximising the methane yield for internal power consumption makes the process more sustainable.



More information available from www.organic.ort.com.au.

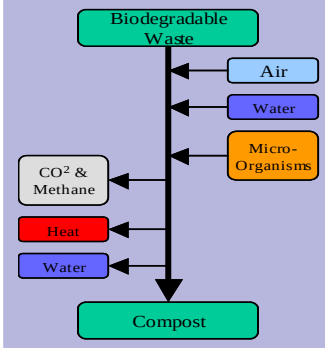
Composting for beginners

When plant material falls to the forest floor, microbes and soil animals break down the organic matter into nutritious topsoil. The decay takes many months, but this natural process can be sped up by composting.

A proper composting process produces substantial heat (>50ºC). This increased temperature (thermophilic) speeds up the waste conversion process and can also kill undesired germs in the compost.

To create ideal conditions for composting it is essential to provide adequate water and oxygen.

If the compost heap is too compact, not enough air can penetrate into it and the composting microbes can no longer work. This allows microbes that can grow without oxygen (anaerobic) to "digest" (anaerobic digestion) the waste, typically producing offensive odours and acids and resulting in failure of the composting process.



If you mix or turn your compost pile every week, it should be ready to use in about three months and should look like dark crumbly soil with a sweet, earthy smell. Good compost will enrich the soil and feed plants and soil animals such as earthworms.

Ausbiotech 2005

EBCRC's Exhibition booth at Ausbiotech 2005

Environmental Biotechnology features for the first time at Ausbiotech

The annual Ausbiotech Conference was held in Perth in late November, 2005. There were over 1000 attendees supporting the conference, around 18% of whom were from overseas.

EBCRC had a stand in the exhibition hall which managed to encourage quite a large amount of traffic. The most common query from passers-by was "so what is environmental biotechnology?"

This shows that there is still a large gap in understanding within the biotech industry itself - something we hope to change over the next few years.

For the first time, there was a session on Environmental Biotechnology. This is an excellent indication that the industry has started to accept environmental applications of biotechnology as a new sector in its own right - rather than one attached to agriculture.

The environment session was chaired by EBCRC's Executive Director, Dr. David Garman.

While the session was well-received, we hope in future to attract a larger crowd and perhaps an earlier time slot!

We look forward to promoting EB again in 2006.

News

Communicating outcomes as important as achieving them

By Pepita Maiden
EBCRC Communications Manager

The biggest event in the EBCRC's calendar is the Research Showcase - the second of which was held in Brisbane last November. This now annual event highlighted the quality of our people and research, and the achievements made in our second year.

The promotion of the CRC's people, research and achievements through these events, as well as the chance they give our researchers to network, is an integral part of EBCRC's long-term strategy.

What's the point of doing all that great work if no-one knows anything about it?

EBCRC is one of the first organisations in Australia to bring the various aspects of EB research under one umbrella, as well as to promote the area of work as a new sector in biotechnology.

Nevertheless, as our experience at Ausbiotech (see panel on left) shows, understanding and perhaps acceptance even within the biotech industry, is still low.

I often hear of research organisations without any strategy for communication. The EBCRC is lucky to have a management and Board that support and invest in marketing and promotions for its research.

Early communications to the government, public, potential investors and potential end-users of our technology will mean a faster take-up of technology and better support for our work within the investment, biotech and general research sectors.

Showcasing performs a number of functions:

- the promotion of the Environmental Biotechnology as a sector to the biotech industry and other important stakeholders
- as a marketing exercise to promote the EBCRC 'brand' to a wider audience
- letting people know about our fantastic research, high calibre scientists, enthusiastic industry partners and our many great research outcomes
- allowing our researchers to meet industry people and network with government and other researchers.

Our Showcase day attracted over 60 attendees from the biotech industry, research institutes, investment organisations and relevant government departments. Also attending were international visitors and representatives from industries relevant to EBCRC research such as water and waste management.

The day started with Paul Ross of Biotechnology Australia and UQ's Paul Greenfield, who gave presentations on Australia's capabilities in EB and some of the problems in industry that EB can help to solve.

Following an outline of EBCRC's research directions and commercialisation programme, case studies were presented on the key EB areas of biofilm control, bioremediation and water and organic waste management.

EBCRC would like to thank our sponsors and all attendees for contributing to the success of this very enjoyable day.

Speakers from EBCRC's senior research team, as well as industry representatives, gave presentations at the Showcase

PhD student Lee Walker, based at Murdoch University, was awarded EBCRC's best student presentation prize

Environmental Biotechnology News

World's next fuel source could be designer organisms

J. Craig Venter, who gained worldwide fame in 2000 when he mapped the human genetic code, is behind a new start-up called Synthetic Genomics, which plans to create new types of organisms that, ideally, would produce hydrogen, secrete nonpolluting heating oil or be able to break down greenhouse gases. The initial focus will be on creating "biofactories" for hydrogen and ethanol. www.checkbiotech.org

Poison + water = hydrogen. New microbial genome shows how

Take a pot of scalding water, remove all the oxygen, mix in a bit of poisonous carbon monoxide, and add a pinch of hydrogen gas. It sounds poisonous but apparently, it is the preferred environment for a microbe known as *Carboxydothermus hydrogenoformans*.

Scientists at The Institute for Genomic Research (TIGR) report the determination and analysis of the complete genome sequence of this organism, which lives almost entirely on carbon monoxide. While consuming carbon monoxide, the microbe mixes it with water, producing hydrogen gas as waste, a potential fuel source. http://science.bio.org

New technology to remove water contaminants

Bruce Rittman from Centre for Environmental Biotechnology at Arizona State University has found a way to remove contaminants from drinking water and is using the same technology to generate electricity. He built a membrane biofilm reactor to remove contaminants, such as nitrate and perchlorate, from water. The same technology is also being studied to capture renewable energy resources to generate electricity from organic materials in water. www.bizjournals.com/phoenix

Biotechnology in Japan

Japan takes biotechnology very seriously considering that old biotechnologies such as fermentation, enzyme production, food additives and fermented foods have played a critical role in Japanese industry. Japan also has very strong markets for taking up new biotechnologies - such as a large healthcare sector under pressure to reduce costs, a food processing industry hungry for new products and growing bioremediation and environmental sectors. www.asiabiotech.com.sg

US Energy Department awards $92 million

The US Department of Energy announced research awards totalling $92 million for six projects to better understand microbes and microbial communities.

The microbial world and biotechnology promise solutions to major challenges in energy - including the production of ethanol and hydrogen, cleanup at former nuclear weapons production sites; and controlling atmospheric CO2.www.eurekalert.org

DNA 'Phylochip' Scans for Disease-Causing Microbes

Hurricanes Katrina and Rita left waters that are heavily populated with disease-causing microbes that could pose a risk long after the waters have been cleared.

A technology developed by scientists at Berkeley Labs holds promise to provide a comprehensive picture of bacterial presence in the air, soil and water and enable authorities to track how that presence changes over time. www.physorg.com

Cow power and sustainable development

Cornell University is looking at the technical feasibility of converting dairy manure-derived biogas from anaerobic digestion to electricity and heat on the dairy farm.

Instead of looking into the present conversion technologies that include the internal combustion engine, he is interested in assessing the feasibility of fuel cell technology for energy conversion of biogas, that might increase farm profitability by well over 20% and reduce waste impacts on the environment by over 25%. www.news.cornell.edu

Beans means biodiesel

The US departments of energy and agriculture will combine their expertise to decode the soybean's DNA because of the legume's value as a source of biodiesel.

The departments will coordinate relevant plant and microbial genome sequencing and bioinformatics - applying the tools of molecular biology to contributing to the development of new avenues for clean energy generation and crop improvement. Application of genomics to soybean requires detailed knowledge of the plant's genetic code. www.biotechnologynews.net

Conferences

10th International Conference on *Pseudomonas*

Marseille, France
27–31 August 2005

By Nicolas Barraud
EBCRC PhD Student

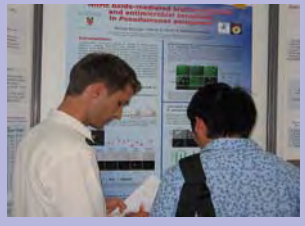
Pseudomonades are ubiquitous bacteria, able to cope with a wide variety of life styles. The versatility of the species and the multiplicity of molecular mechanisms involved in adaptation and colonisation can be used as model for many other organisms.

The conference covered all facets of the latest *Pseudomonas* research, including genomics, host–bacteria and environment–bacteria interactions, physiology and biofilms.

A variety of specialised topics were covered, with an emphasis on quorum sensing systems and biofilm biology. With the help of genomics, many studies have made considerable progress in investigating new signalling systems.

During the poster presentation, many researchers showed great interest in my research on nitric oxide-mediated biofilm cell death and dispersal mechanisms.

I was asked some pretty tough questions but also received good advice for continuing my research and publishing it.



Presenting my poster to a Japanese postdoc

Information

Events

A number of exciting seminars and conferences are planned for 2006. Keep your eye on our website for an updated list of events (www.ebcrc.com.au)

Publications

Annual Report

EBCRC's Annual Report for 2004-2005 is available. You can download an electronic copy from our website or alternatively, contact Pepita Maiden for a CD or paper copy.

Website

The EBCRC website is in the process of being redesigned to better reflect the EBCRC and its work. More, and more easily accessible, information will be available. The new site, due for launch in March, will be simpler to use and have a more modern look.

In the meantime, our current website (www.ebcrc.com.au) is still live and is updated regularly.

Brochures

Our easy to read brochures outline our research and objectives. There is a simple explanation of each of our research projects.

Please contact us for copies of any of these items, or if you would like further information.

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