

## **Department of Microbiology and Plant Pathology**

**Annual Report 2006**

### **University of Pretoria**

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## Message from the Head of the Department Prof T E Cloete

The year 2006 is rapidly drawing to an end and it is again time to reflect on the year gone by. This year will be remembered for 3 new initiatives in the department. The first initiative was the introduction of the International Brewing Diploma offered in collaboration with SA Breweries, The International Institute of Brewing and Distilling and the Food and Beverage SETA. The Department of Education also made the department of Microbiology and Plant Pathology a Centre of Excellence for delivering this diploma.



The second initiative was the introduction of a new MSc degree in Water Resource Management in collaboration with the Georgia Institute of Technology in Atlanta, USA.

The students who complete this 2 year programme will receive a truly international degree, with the emblem of both universities on the degree certificate. Prof A Georgakakos, the Director of the Water Research Institute at Georgia Tech was also appointed as an extraordinary professor as part of the collaboration and new degree programme.

The third major initiative was the establishment of the University of Pretoria Water Institute. Our Department will play an important role in this institute comprising 40 scientists from 6 faculties. I have been charged with the responsibility to manage the institute and will serve as the first Director.

# PERSONNEL

## Doserende personeel / Lecturing staff



**Prof Cloete TE:** DSc(Pret)  
Pri Sci Nat – Professor and Head



**Prof Korsten L:** PhD(Pret)  
Professor



**Prof Nel LH:** PhD(Pret)  
Professor



**Dr Pietersen G:** PhD  
Extra-ordinary Professor



**Dr Wolfaardt F:** PhD  
Snr Lecturer



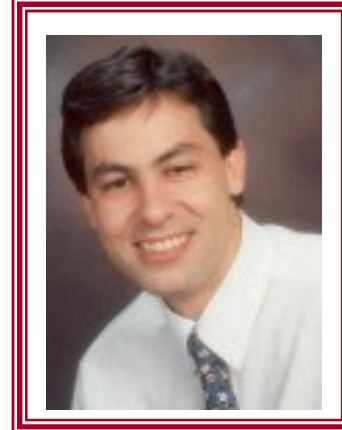
**Prof Aveling TAS:** PhD(Natal)  
Associate Professor



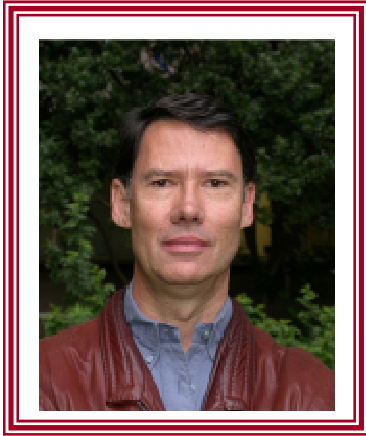
**Prof Venter SN:** PhD  
(Pret) Snr – Associate Professor



**Prof Coutinho TA:** PhD (Natal)  
Associate Professor



**Prof Theron J:** PhD(Pret)  
Associate Professor



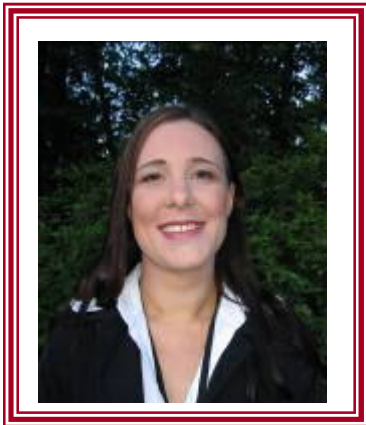
**Prof Labuschagne N:** DSc(Agric)  
(Pret) Pri Sci Nat –  
Associate Professor



**Dr Viljoen A:** PhD (UOVS) – Snr  
Lecturer



**Dr Steenkamp E:** PhD (Pret)  
Snr Lecturer



**Miss Markotter W:** MSc (Pret)  
Jnr Lecturer



**Miss M S Thantsha:** MSc (Pret)  
Jnr Lecturer

## Technical assistants



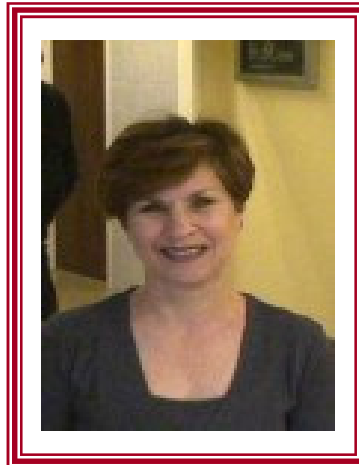
**Ms van Dyk K:** MSc(Pret)



**Mr Pretorius M:** BSc(Hons)(Pret)



**Mrs Truter M:** MSc(Pret)



**Mrs Bosch A:** Nat. Diploma

## Support Staff



**Mrs Madelein Botha:** Secretary

Mrs Lilian Motale  
Mr Albert Molefe

## Industry Funded Staff (Citrus and Subtropical)

**Ms A Redmond:** Technical Assistant  
**Ms T Beart:** Technical Assistant  
**Ms D Muller:** Administrative assistant  
**Dr L Meyer:** Research Assistant  
**Mrs K Zeeman:** Technical Assistant  
**Ms C Joubert:** Research Assistant  
**Mrs A Lombard:** Technical Assistant  
**Mrs R Jacobs:** Research Assistant  
**Dr T Regnier:** Research Assistant



# HONOURS STUDENTS



## Microbiology Honours 2006:

**Front row left to right:** Johan Fouchè, Trisha Desai, Marcele Vermeulen, Clinton Moodley

**Middle row Left to right:** Nokukhanya Nxumalo, Botumelo Mashangoane, Apiwe Nxusani, Dominique Anderson, Nicolette Fouchè, Stacey Collignon, Amelia Keyser, Charmaine Wilsenach, Letitia Burger, Boitumelo Pule

**Back row Left to right:** Marius Schwerdtfeger, Warren Wiese, Wayne Barnes, Pieter Swanepoel, Renate Lamprecht

## MSc - Students

R. Maluleke	L. Stronkhorst	Z. Dlamini
C. Phasha	J. B Meyer	P. Coetzee
J. Mavhungu	J Boshoff	O. Koch
P. Randima	W Keesenberg	S. Muvhulawa
J le Roux	H van der Merwe	E. Ngoepe
S, Groenewald	D. Echeverri	B. Phaladira
R. Sutherland	C. Beukes	N. Phalatsi
J. Walker	N. v Zyl	K. Stewart
G. Britz	L. Botha	G. Zulu
A. Botha	BT. Demon	M. Wilmot
L. Swart	K. Nxumalo	
M. Kvas	C. Millard	
D. Pavlic	A. vd Merwe	
G. Ross	H. Geyer	
C. Johnston	C. Munro	
G. Britz	P. Papanu	
M. Nieuwoudt	A. Kotze	
J. Roos	Z. Dlamini	
N. van Blerk		

## PhD - Students

C Brady	S. Shikongo-Nambabi
P de Maayer	E. Madoroba
S. Y. Athman	S. September
B. Steyn	K. Surridge
P. Oberholster	I. Paul
R. Dube	L. Burger
M. Said	P. Storey
I Tshivandekano	B. Böhmer
N. van den Berg	E du Plessis
J. de Graaf	B. Dungu-Kimbenga
G. W du Plooy	S. Maree
A.I. Hassen	W. Markotter
J. Bloem	

## Water Resource Management - Students

Bapela, MB  
Cholo, KWW  
Ejigayehu, N  
Esterhuizen, M  
Jikijela, SML  
Louwrens, R  
Malisawa, MS  
Masetla AI  
Mkebe, NM  
Ndasowampangi EP  
Njoroge, S  
Phaladi, MTP  
Qwabe, VS  
Thobejane, TA

## AWARDS

1. **M. Said:** Award for the best platform presentation on the Cholera epidemic in KwaZulu Natal. 3<sup>rd</sup> International Young Researchers Conference held at the Nanyang Technological University of Singapore.
2. **J Gumbo:** Award for the best student poster. 12<sup>th</sup> International Conference on Harmful Algae held in Copenhagen, Denmark.
3. **Prof T E Cloete:** Finalist in the NSTF Science and Technology Award for Capacity building over the past 10 years.
4. **Prof T E Cloete:** UP Exceptional Achiever Award
5. **Prof T E Cloete:** NRF B1 rating
6. **Dr A Viljoen:** Sameroeper van die Internasionale PROMUSA werksgroep op Fusarium verwelking van piesangs.
7. **Prof L Korsten:** National Laboratory Association Board member 2005-2006.
8. **Prof L Korsten:** South African National Accreditation Systems Award for special recognition for a significant contribution towards improving and promoting SANAS accreditation.
9. **Prof L Korsten:** Thrip runner-up: SMME development: The project that contributed to the improvement of the competitiveness of the SMME industry partner.
10. **Dr Jaqueline Weyer:** L'Oreal – Unesco PhD Fellowship award for academic excellence.
11. **Katherine Stewart:** Best Award at the 4<sup>th</sup> Citrus Research Symposium in Port Elizabeth.



## GUEST RESEARCHERS AND ASSOCIATES

1. The phytopathogenic bacteria research group has a collaborative project on the Genus *Pantoea* with the Laboratory for Microbiology at the University of Gent, Belgium. This project is jointly funded by the Flemish and South African Governments. In July 2006, Professor Jean Swings and Ms. Ilse Cleenwerck visited our research group to discuss progress of the joint project.
2. Dr. Jan Rademaker from NIZO, the Netherlands, visited our group for a week in January. He is collaborating with us on a *Xanthomonas* project.
3. Prof A Georgakakos, Dr F Kimaite, Prof T Sturm and Prof H Wao: Visit to SA and the Water Institute of the University of Pretoria in August 2006. They are from University of Georgia Tech, USA.
4. Prof J Bore (INRA France) – International experts on Citrus greening disease joined by Prof Pietersen, Korsten and members of CRI on a collection trip of greening infected citrus trees in Nov/Dec 2006 in order to identify the causal organisms.
5. Dr P Yamato (Fundecitrus, Brazil) - International experts on Citrus greening disease joined by Prof Pietersen, Korsten and members of CRI on a collection trip of greening infected citrus trees in Nov/Dec 2006 in order to identify the causal organisms
6. Dr A Lores (Fundecitrus, Brazil) - International experts on Citrus greening disease joined by Prof Pietersen, Korsten and members of CRI on a collection trip of greening infected citrus trees in Nov/Dec 2006 in order to identify the causal organisms.
7. Prof R Atlas, University of Louisville , Biology Department, LOUISVILLE, KY. Visiting the Department for the Launch of the Book: Basic and Applied Microbiology.

## EXTRAORDINARY PROFESSORS



Prof P Ashton, CSIR, Pretoria,  
South Africa



Prof H Kasan, Rand Water,  
Johannesburg, South Africa



Prof WOK Grabow, Pretoria,  
South Africa

# INTERNATIONAL VISITS BY STAFF & STUDENTS

1. **Prof T E Cloete**  
IWA Executive Committee Meetings, London, February 2006
2. **Prof T E Cloete**  
IWA Executive Committee Meetings, Budapest, Hungary, June 2006
3. **Prof T E Cloete**  
IWA World Water Congress, Beijing, China, September 2006
4. **Prof T E Cloete**  
IWA Executive Committee Meetings, Beijing, China, September 2006
6. **M Said:**  
3<sup>rd</sup> International Young Researchers Conference held at the Nanyang Technological University of Singapore. Cholera epidemic in KwaZulu Natal.
7. **J Gumbo:**  
The International Society for the Study of Harmful Algae (ISSHA) held the 12<sup>th</sup> International Conference on Harmful Algae from 4-8 September 2006 in Copenhagen, Denmark.
8. **G Ross:**  
The use of Phoslock for the control of eutrophication. IWA World Water Conference, Beijing, September 2006
9. **M S Thantsha:**  
XIV International workshop on Bioencapsulation and cost 865 Meeting, Lausanne, Switzerland, October 2006.
10. **Prof L H Nel, Me W Markotter, Me J Weyer, Me N Phalatsi, Mr P Coetzee, Me N Van Zyl:**  
8<sup>th</sup> SEARG meeting, Namibia
11. **Prof L H Nel:**  
12<sup>th</sup> ISID meeting, Portugal  
10<sup>th</sup> –RNA meeting, Spain  
17<sup>th</sup> RITA meeting, Brazil
11. **Dr J Weyer:**  
9<sup>th</sup> Vaccine conference, USA
12. **W Markotter and N Phalatsi:**  
Centers for Disease Control and Prevention, Atlanta, USA
13. **Prof L Korsten:**  
CIES International Food Safety Conference, Paris, France. February 2006

14. **Prof L Korsten:**  
Postharvest Training Project for FAO, Kenya and Tanzania, 19-26 February 2006
15. **Prof L Korsten:**  
Postharvest Training Project for FAO, Malawi, 17-20 April 2006
16. **Prof L Korsten:**  
Visit various laboratories and institutes for World Bank Project, Uganda, 7-12 May 2006
17. **Prof L Korsten:**  
Visit various laboratories and institutes for World Bank Project, Peru, July 2006
18. **Prof L Korsten:**  
Eurepgap Congress, Prague, September 2006
19. **Prof L Korsten:**  
Represents SANAS at Eurepgap Workshop, Cologne, Germany 20-22 November 2006
20. **Prof G Pietersen**  
Attended International Huanglongbin-Greening Workshop; Ribeiro Preto, Brazil, 16-20 July 2006.

## RESEARCH

### 1. ENVIRONMENTAL MICROBIOLOGY

#### **Innovative applied research in water resource management**

Unsafe drinking water places tremendous stress on the health and lives of millions of people living in isolated rural areas with no access to potable water. The resultant spread of water-borne diseases, including cholera, is especially severe in developing countries, causing some 60 percent of all infant mortality. There is an urgent need, globally, for practical, inexpensive and sustainable technologies that provide people in rural communities with access to potable water.

#### **Solar pasteurisation alleviates health risks**

The effective microbial purification of drinking water is an important consideration in preventing the transmission of waterborne diseases. Conventional water treatment processes commonly use chemical disinfectants, which are relatively expensive and require skilled labour in its application. While effective in developed areas, the challenge lies in providing a practical treatment solution for communities in rural areas. A team of researchers at the Department of Microbiology and Plant Pathology at the University of Pretoria has addressed this challenge head on with the design of a solar pasteurisation system that enables communities to cost-effectively purify contaminated water.

Water samples taken from a river were heated with solar energy at different temperatures and indicators of microbiological pollution used to monitor the disinfection process. The results indicated that solar pasteurisation at temperatures exceeding 65°C for a minimum of 60

seconds could successfully and cost-effectively decontaminate water. The solar panels are made of black plastic piping. Operating the system is straight forward, requiring skills easily transferable to members of rural communities.

Contaminated water is added to the system and exposed to sunlight until the desired temperature is reached. This brings the bacteriological standard of the water to a recognised level for potable water. Depending on the need, systems can be constructed to produce from a few litres to a few thousand litres of potable water per day.

The solar pasteurisation system can also be applied to help prevent the spread of diseases such as cholera, which is transmitted through infected drinking water and food contaminated with the *Vibrio cholerae* bacterium. Sudden large outbreaks such as the one in KwaZulu Natal in August 2000, which developed in the most serious cholera epidemic yet experienced in South Africa with more than 30 000 cases reported in 2001, are usually caused by a contaminated source of drinking water.

The greatest risk occurs in communities with poor sanitation and unsafe drinking water. Improvements in water supply and sanitation in rural areas to alleviate health risks are often the more difficult to achieve as it requires technological intervention. The management of the cholera epidemic in KwaZulu Natal has shown, however, that with the right intervention historically dreaded diseases can be controlled despite large numbers of infections.

### **Detecting microbial waterborne pathogens**

Population growth and globalisation have increased the rapid movement of people across continents, escalating the spread of new strains of waterborne pathogens world-wide. This presents a significant challenge in water resource management, for which comprehensive reviews of the latest available information is fundamentally important.

Experts of international standing, led by Prof Eugene Cloete, Head of the Department of Microbiology and Plant Pathology at the University of Pretoria, recently published the book *Microbial Waterborne Pathogens*. The book is widely regarded as a complete reference book for academics, practitioners, advanced students and regulatory authorities on the microbiological quality and safety of potable water.

It reviews the latest information on all the existing and emerging pathogens including bacteria, viruses and protozoa, and their epidemiology. The book looks at pathogen detection methods and control strategies in water resources and supplies, and covers the link between climate and disease, indicating future approaches for dealing with this important aspect as we face the effects of global climate change. This book makes a valuable contribution to a better understanding of traditional and new strains of waterborne pathogens in its presentation of the latest available information in this field.

### **Helping manage industrial water systems**

The use of water is integral to most industrial production processes, such as in the mining and food and beverage industries. Given the imperative on these industries to conserve and optimally utilise water resources, two research projects have been undertaken by the Department to assist industry to reduce consumption and alleviate environmental impact.

A multi-disciplinary project for the mining industry has resulted in the patenting of an integrated and managed passive treatment process that uses naturally available energy sources to treat mine waste water. Managed by Pulles Howard and de Lange and incorporating input by researchers of the Universities of Pretoria, Rhodes and Witwatersrand, the process addresses the problem of acidification and salinisation at operating, defunct and closed mines in South

Africa.

The final phase in the IMPI Process (Integrated Managed Passive treatment process) development programme, currently underway, is the design and implementation of full-scale low cost, low maintenance and self-sustaining treatment systems within the mining industry.

And to assist the food and beverage industry to meet ever-increasing food safety requirements, the now internationally patented Rotoscope Biofouling Monitor effectively monitors the formation of unwanted biofilm and releases biocide to disperse the build-up before the biofilm becomes a serious problem.

Initially reported on in 2003 when international patents were pending, the Rotoscope – which is significantly more affordable than other monitoring systems – is being manufactured and marketed to the food and beverage industry by BTC Products and Services.

Additional research highlights at the Department of Microbiology and Plant Pathology include:

- assisting government to develop policies to improve the water management systems in industry, which involves determining the industries that use water and the quantities used, as well as the amount and composition of the effluent produced looking at bacteria that are resistant to the biocides used to kill them to assist both industry and the manufacturers of the biocides developing biological control methods to combat the Eutrophication of dams, using the bacteria kill the toxin-producing algae that cause the Eutrophication and are harmful to humans and animals and aesthetically problematic
- Investigating, with the CSIR, a viable alternative to waterborne sanitation such as eco sanitation or dry sanitation, for which one thousand dry vault latrines have been installed in KwaZulu Natal.
- examining two eco-friendly disinfection techniques using chlorine dioxide or the electrochemical activation of water, both of which show decided promise for industrial application as well as in the provision of potable water.

### **Bacterial pathogens in water**

The research focus entails the development of detection and identification methods, as well as a study of the fate (survival) of water-borne pathogens. The focus of the present study is to develop a better understanding of the fate and behaviour of enteric pathogens in aquatic environments Using *Salmonella Typhimurium* as model organism. Currently the survival and growth of this organism in fresh water sediments are studied using a GFP labeled strain. The prevalence of bacterial pathogens in biofilms associated with drinking water is also investigated.

### **Environmental biotechnology**

The use of micro-organisms to inhibit pollution is researched. Emphasis is placed on water pollution with special reference to waste water, industrial waste water, industrial effluent cooling water and water supply.

## **2. *Fusarium* diversity in SA**

The objective of this research programme is to obtain a global idea of the evolution of species in the fungal genus *Fusarium*. The research focuses strongly on relationships within and among species, but also on deeper taxonomic relationships among sections and/or species complexes. Accordingly, our major goals are to:

- characterise *Fusarium* species that are of ecological, agricultural, commercial and medicinal value using morphology- and DNA-based approaches;



- analyse the population biology of these important species using cultural and molecular characters; and
- build an overall picture of the relationships among *Fusarium* groups, sections and species complexes using molecular phylogenetic approaches.

### 3. Rhizobial diversity associated with indigenous legumes.

Our overall objective is to characterise the diversity of rhizobia associated with Southern African legumes, especially those that are of agricultural, commercial and medicinal value. To accomplish this, we isolate and identify the rhizobial bacteria from the root nodules of legumes from various regions in Southern Africa. Such identifications are generally achieved with a combination of traditionally used morphology and biochemical tests, as well as DNA-based approaches. These bacteria are also evaluated for their ability to nodulate and to fix atmospheric nitrogen. Ultimately these data provide an indication of the distribution of rhizobial species and their ecological significance for indigenous legumes.

## 4. PLANT DISEASES AND THEIR CONTROL

### Soil-borne diseases research program

(Program leader: prof. Nico Labuschagne)

#### Application of Growth-Promoting Rhizobacteria (GPRB) for biological control of soil-borne diseases.

GPRB are being tested for its biocontrol activity against root diseases of various crops including selected vegetable crops as well as wheat and sorghum. The pathogens included in the study are *Pythium* and *Fusarium* spp., *Phytophthora capsici*, and *Rhizoctonia solani*. Very promising results have been obtained against all of these pathogens and some of the biocontrol agents are currently being commercialised. *Pythium ultimum* specifically is a common soilborne pathogen causing root rot in a wide range of greenhouse and field crops, including sorghum. In a field survey conducted in Ethiopia, Sorghum (*Sorghum bicolor* (L.) Moench) plants showing root disease associated symptoms were selected and the pathogens isolated from infected roots. More than 90% of the isolates were identified as *P. ultimum*. Rhizobacteria isolated from the rhizosphere of sorghum in Ethiopia and from the rhizosphere and rhizoplane of different grass species within the Nylsvlei Nature Reserve in South Africa were evaluated for their *in-vitro* and *in-vivo* antagonistic activity against a virulent isolate of *P. ultimum* that caused root rot in sorghum under greenhouse conditions. Significant suppression of the disease was achieved by 23 bacterial isolates most of which were able to colonize the sorghum rhizosphere at  $\geq 10^5$  CFU g<sup>-1</sup>. Of the effective isolates identified as members of the Genus *Bacillus* by means of API and sequencing of 16S rDNA, 56% were *Bacillus cereus* of which *B. cereus* KBS5-H, *B. cereus* KFP9-A and *B. cereus* KFP9-K rendered 100%, 98.7% and 96.5% disease suppression respectively. Three other isolates effective in this study were identified as *Brevibacterium laterosporus*, *Pseudomonas fluorescens* and *Serratia marcescens* which resulted in 90.7%, 83.8 % and 86.3% disease suppression respectively.

A study of the modes of action using the most effective rhizobacterial isolates indicated that production of siderophores, secretion of extracellular chitinase enzyme and production of antibiotic substances are involved in the suppression of *P. ultimum* by these isolates. Induction of systemic resistance is also currently being investigated. The application of rhizobacteria as inoculants in agriculture to control soilborne root diseases in most African countries is poorly developed. The results obtained in this study provide valuable information on the existence of potential biocontrol agents to control *P. ultimum* in sorghum.

## **Etiology and control of root diseases of hydroponic crops**

*Pythium* wilt and root rot causes serious losses in hydroponic crops locally as well as internationally. Until recently there has only been a limited number of cultural practices and chemical treatments to combat this disease. New research has shown that water sanitisers can reduce *Pythium* levels in the irrigant water, with subsequent reduction in crop losses.

Biocontrol organisms as well as various chemical treatments have been investigated for their efficacy against *Pythium* in the greenhouse as well as in a field hydroponic system on the university's experimental farm. Several bacterial isolates significantly suppressed the disease. These isolates are currently being commercialised by a private company. Various chemical treatments are being tested and it was demonstrated that K-phosphonate applied to the nutrient solution effectively controls the disease.

## **Litchi**

The South African litchi growers experience a high percentage of losses at the export end of the fruit chain, which prevent them from attaining premium prices on the export markets. Understanding the factors that contribute to postharvest decay and managing it more effectively to ensure quality remains a critical aspect for the industry if future growth is to be ensured. In addition, recent international requirements to ensure product safety have forced the industry to become Good Agricultural Practices compliant and adopt food safety systems such as HACCP and/or BRC. Although producers remain responsible for the product until it is sold at the retail end, they do not control the product once it leaves the farm gate. Reliance on exporters, importers, distributors etc. therefore becomes critical. If handlers of the fruit further down the chain do not similarly comply with basic hygiene standards and careful handling practices, product quality can be severely compromised. A recent study by Prof Korsten's team on citrus indicate that this might play a far more important role than previously anticipated and that the blame for poor quality should not necessary only be placed on the shoulders of the producer. Litchi, which is a far more fragile fruit, might even be more affected than citrus. Food safety and quality is a shared responsibility and require a holistic approach to achieve the ultimate goal of best quality consistently. Further, a critical need exists to find a replacement for SO<sub>2</sub> fumigation for litchis since the EU and the USA will not accept fruit treated with sulphur. This places pressure on the local industry to urgently find an effective alternative which is part of this project's main objectives.

## **Mushroom**

In the commercial cultivation of mushrooms, compost colonized with mushroom mycelium is covered with a casing layer, to initiate development of mushrooms. In this layer the switch from vegetative (mycelium) to reproductive (mushroom) growth takes place. Physical, chemical and microbiological factors determine the suitability of a casing material. Peat neutralized with calcitic lime is the most widely used casing material for mushroom cultivation throughout the world. Its water holding capacity and structural properties are widely accepted as ideal for the purpose of casing. However, problems associated with its use, especially regarding its availability which is directly linked to the depletion of our natural reserves and the alteration of ecosystems, have led to the search for alternative materials. Standard physical, chemical and

biological methods need to be defined and used as parameters in the evaluation of different agricultural waste products (i.e. citrus, sugarcane and grape byproducts) as potential casing materials. Physical parameters are essential in defining substrates for casing materials, because the main role of such substrates is to provide the proper physical conditions for mushroom development. The most important parameters are: pH, electrical conductivity, bulk density, porosity and water holding capacity. If so, then it should be possible by means of tests to predict whether a particular substrate has the potential to be a good casing material. Furthermore, this information might allow us to alter a particular casing material to improve on its cropping potential. In order to have performance characteristics at least equal to peat, competitive cost, stable quality, continuity of supply, free from pests and diseases and easy to handle are some of the characteristics that can be used to screen byproducts.

## **Citrus**

The South African citrus industry is the 12th largest citrus producer in the world, and the third biggest exporter of the fresh fruit. Currently 60% of all citrus produced in South Africa is exported fresh to mainly European countries. Currently, the industry is negotiating market access into the USA and China which will cause significant growth in this sector. However, with increased free trade comes new restrictions in the form of phytosanitary barriers to trade. Citrus Black Spot caused by *Guignardia citricarpa* Kiely is one of the most important fruit diseases on citrus in South Africa and other mainly southern hemisphere countries. The disease does not occur in European citrus producing countries and has therefore become a major barrier to trade despite the more than 80 years of unrestricted exports from South Africa to the EU. In order to remain competitive on the European markets and to access new markets, a risk assessment study had to be done to ensure continued access into the EU. Comments and concerns from the EU on the RA document from South Africa have been addressed during the initial phase of the citrus research program. With this new application the industry requires that we develop an effective long term strategy to manage the disease by means of more effective monitoring of inoculum levels, using biological control systems and improving the disease forecasting model to incorporate actual direct monitoring of the pathogen into the model. In addition, ensuring that the South African citrus industry remains competitive on the international markets, it will have to consider new sweeping changes to maximum residue levels required for most pesticides and the continuing loss of postharvest fungicides. In order to ensure top quality produce that can sustain the export distance, new environmentally friendlier control products will have to be developed, registered and commercialized. The second main objective of this research program was therefore to develop alternative disease control products for the South African citrus industry.

1) Establishment of a diagnostic capacity for the detection of viruses and other graft-transmissible pathogens of Citrus. Funding by Citrus Research International (2005-2007). Vestiging van 'n diagnostiese vermoë vir die opsporing van viruses en ander ent-oordragbare siektes van Sitrus. Befonds deur Citrus Research International (2005-2007) Rapid, sensitive and accurate diagnosis and identification of pathogens is fundamental to development of strategies for their management and control, whether by phytosanitary legislation, certification schemes, vector control, resistance selection and breeding, or cultivation practices. Development of such techniques is also an essential first-step in most research actions involving such pathogens. In support of the local citrus industry the aim of this project is to establish a diagnostic capacity (ELISA- or PCR-based) locally to detect the major graft-transmissible diseases of citrus. To address the control of citrus tristeza virus (CTV) by cross protection, and to exploit the probable underlying mechanism of RNA-silencing, it is imperative that information on the variability of this virus be obtained locally. Micro-array based analysis is ideally suited to this, and such a technique is being developed.

## 5. Phyto bacteriology

This research programme focuses on bacterial diseases of plants. The interest has primarily been on *Pantoea ananatis* and related *Pantoea* species. *P. ananatis* is responsible for bacterial blight and die-back of Eucalyptus, brown stalk rot of maize and occurs on onion seed in South Africa. Our studies have centred on taxonomy and on developing rapid and reliable methods of distinguishing between the species of this genus. Other elements currently under investigation include understanding the epidemiology and biology of *P. ananatis* in South Africa and identifying pathogenicity factors in this pathogen.

The second focal area of this programme is on *Xanthomonas* spp. associated with bacterial blight of eucalypts and the species responsible for banana wilt in central Africa. Only one species of *Xanthomonas* has been found to cause a disease of eucalypts (*X. eucalypti*) and thus far this pathogen has only been reported in Australia. The objective of study is to determine whether or not this species is associated with blight elsewhere in the world. With regards to banana wilt, our aim is to confirm the identity of the causal agent and undertake a population study to determine its origin and movement through the various countries in central Africa.

## 6. Diseases of indigenous food crops grown by resource-poor farmers

Many of the 20 000 indigenous plant species described in South Africa not only provide for the daily needs of millions of people but are also rich sources of genetic material from which selections can be made for commercial utilisation. The production of food in increasing quantities is a challenge for coexistence of our national and international societies. In this activity the industrialized countries are making important progress. However, in South Africa, a "developing country", there are still difficulties for achieving the production of agricultural products in qualities and quantities sufficient for maintaining a properly sustained population. About half of the food produced for human consumption on land is estimated to be lost through the ravages of insects, fungi and other organisms. Attacks start prior to harvest and continue during subsequent transport and storage. Even a modest reduction in the percentage losses through such causes, will consequently have a not inconsiderable impact on the production levels achieved in a country.

### Cowpea

Cowpea (*Vigna unguiculata* (L.) Walp.) is one of the most important legume crops in Africa. Cowpea grows on a wide variety of soils from sandy to heavy clays but grows better on well-drained 'sandy substrates'. Cowpea is relatively more tolerant to drought stress than other common legumes. Propagation of cowpea is by seed. Common cowpea is traditionally grown in Africa intercropped with cereals like millet, sorghum or maize, at wide spacing.

Africa has the lowest average yield of cowpea (200kg/ha) as compared to 1ton/ha in the USA and between 500-600 kg/ha in other countries. Among the limiting factors to cowpea production is diseases and insect pests. Cowpeas are attacked by at least 35 major diseases caused by fungi, bacteria, viruses and nematodes. In other countries the major diseases include Septoria leaf spot *S. vignicola* and *S. vignae*, Cercospora leaf spot (*C. canescens* and *C. cruenta*), anthracnose, web blight, scab and brown blotch. The research group does surveys and research on the diseases of cowpea on small-holder farms in the Mpumalanga, KwaZulu-Natal and Northern provinces. As the crop is grown in greater abundance, in closer proximity to one another or once monoculture is introduced, the potential threat of diseases and epidemics may

become a reality. Authorative and timely disease recognition is crucial. Pathogens need to be recognized quickly in order to be contained and then eliminated before they become so well-established that eradication is no longer a practical option. Even more crucial is the recognition of possible harmful species in or on seeds and plant materials. In both these cases, adequately knowledgeable staff must be readily available for both survey and diagnostic work, and in addition these personnel require speedy channels to access specialists with the necessary resources to advise quickly on problematic cases. Reliance on distant overseas identification centres cannot provide the timely service vital for effective preventative measures. The programme has been expanded to include Bambara groundnut.

## **7. Seed Pathology**

Some research is also being done on seed pathology, vigour and fungicide treatment of maize and legumes grown by small-holder farmers.

Prof. Aveling is Vice-Chairperson of the Storage Committee of the International Seed Testing Association, member of the Plant Disease Committee of the International Seed Testing Association and member of the Scientific Programme Advisory Committee (SPAC) for the 28<sup>th</sup> International Seed Testing Association Symposium to be held in Brazil in 2007.

## **8. Virology**

### **Department of Microbiology and Plant Pathology staff**

Dr. Louis Nel (Professor)

Dr. Gerhard Pietersen (Extra-ordinary Professor)

Wanda Markotter (Junior lecturer)

### **Collaborators and co-workers (include the following individuals/institutions)**

Dr. Anthony Fooks (Veterinary Laboratory Agency, Weybridge, UK)

Dr. Kerstin Kruger (Department of Zoology and Entomology, University of Pretoria)

Dr. Hennie Le Roux (Citrus Research International)

Dr. Barry Manicom (ARC-ITSC, Nelspruit)

Dr. Janusz Paweska (Special Pathogens Unit, NICD, South Africa)

Dr. Jenny Randles (Allerton Veterinary Laboratory, Pietermaritzburg, South Africa)

Dr. Charles Rupprecht (Rabies unit, Centers for Disease Control and Prevention, Atlanta, USA)

Dr. Claude Sabeta (Rabies unit, Onderstepoort Veterinary Institute, South Africa)

Dr. Bob Swanepoel (Special Pathogens Unit, NICD, South Africa)

Dr. Peter Taylor (EThekweni Heritage Department, Natural Science Museum, Durban, South Africa)

Dr. Noel Tordo (Pasteur Institute, France)

Dr. Fanie van Vuuren (Citrus Research International)



Dr. Marietjie Venter (Department of Medical Microbiology, University of Pretoria)

Dr. Alex Wandeler (Canadian Food Inspection Agency, Ontario, Canada)

### **Postdoctoral fellows**

Dr. Jacqueline Weyer

### **Doctoral students**

Wanda Markotter

### **Master students**

Liz Botha

Peter Coetzee

Zama Dlamini

Orienka Koch

Alette Kotze

Jacolene B Meyer

Shirley Muvhulawa

Ernest Ngoepe

Baby Phaladira

Nantu Phalatsi

Katherine Stewart

Nicolette van Zyl

Gugu Zulu

### **BSc Honours students**

Johan Fouche

Renate Lambrecht

Charmaine Wilsenach

## **Research activities and interests: 2006**

### **A: Evolution of Rhabdoviruses and epidemiology of lyssaviruses**

The origin and evolution of viruses are of as much interest in the discipline of virology as is the evolution of life forms to paleontology, and is also important in understanding future evolution of new virus strains. The genetic evolution of the lyssaviruses within the Rhabdoviridae family has become one of our main interests. Elucidating the epidemiology and evolutionary history of two indigenous viral lineages, viz. Mokola virus and the mongoose rabies virus, are core

objectives of this research interest. Within the *Mononegavirales*, the *Rhabdoviridae* is a family of which the members cumulatively infect more than 200 species, which include a broad variety of plants, insects, fish, birds and mammals. Among the lyssaviruses (one several genera) it is of particular interest that Mokola virus has been found in insectivorous shrews and the virus is known to be able to replicate in insects and insect cells – it is also the only lyssavirus for which a reservoir species is not known and, bizarrely, it has never been isolated from bats. All the other lyssaviruses can either be transmitted by insectivorous bats or are exclusive to insectivorous bats. This last category also includes the putative Asian genotypes i.e. Aravan, West Caucasian bat virus, Khujand and Irkut viruses. Three other rhabdoviruses were once considered as putative lyssaviruses, and have been encountered in insects only, viz. Rochambeau, Obodhiang and Kotonkan. It is therefore tempting to speculate that bat lyssaviruses emerged from an insect rhabdovirus and that one of these emerged as the now global classical dog rabies virus. Dog rabies emerged only in recent decades over much of the world, including Africa and continues to radiate in new host species.

- (1) Recently, an excellent plant virology programme has joined our laboratory. Jointly, ours is one of few virology laboratories in which animal and plant viruses are studied in parallel. On this opportune interface, it is our intention to carry out a more comprehensive molecular evolution study of the rhabdoviruses of animals, insects and plants. A number of new and unidentified nucleo- and cyto-rhabdoviruses from South Africa will be studied, together with insect rhabdoviruses of African origin and animal viruses such as Mokola and rabies viruses. These studies will involve the generation of molecular epidemiological clocks and other bioinformatical information, but also investigate physical and biological properties of viruses such as the relative ability to grow on various types of animal and insect cells.
- (2) There has never been any comprehensive epidemiological study of Lagos Bat virus or Mokola virus and these viruses remain among the most obscure in the Lyssavirus genus. However, these lyssaviruses have been encountered everywhere on the continent, where it was competently looked for and we have described various recent isolations of Mokola and LBV from South Africa. Most recently we regularly isolated LBV from bats, but also isolated LBV for the first time from terrestrial wildlife and implicated LBV in rabies vaccine failures of dogs. These findings re-emphasized our lack of understanding of the pathogenicity or epidemiology of lyssaviruses throughout Africa and renewed the interest in the rabies-related viruses in particular. Internationally, these aspects are closely linked to similar questions of other lyssaviruses – including the newly discovered viruses from Asia as well as the better known genotypes like the European and Australian bat lyssaviruses. As one of our contributions towards a better understanding of the genetic diversity, geographic origin and pathogenesis of the phylogroup II viruses we have initiated a molecular epidemiological analyses of all the LBV isolates and all the Mokola virus isolates, both those newly isolated here and those available from local and international archives. It has already become evident that errors have been made in the classification of various isolates and we hope to contribute to a better understanding of the epidemiology of the African lyssaviruses. Apart from the quest for vaccines that will protect against the non-rabies lyssaviruses, the most fundamental questions regarding Lagos Bat virus and Mokola virus and their similarities or differences with rabies virus remains: (1) the identification of the reservoir of Mokola virus and whether or not this virus can infect bats (as all the other lyssaviruses do); (2) whether or not Lagos Bat virus could be regarded as a potential threat to human health (as all the other lyssaviruses are). In searching for answers, we have initiated a comprehensive analyses and comparison of pathogenicity of these viruses in appropriate animal models.
- (3) Following our characterization of the southern African mongoose rabies virus, the origin of this apparently unique variant of rabies virus in southern Africa has become even

more intriguing and there seems to be at least two possible explanations, which our future research will explore and seek to clarify - briefly: (1) A separate introduction from bats to small herpestid carnivores of southern Africa, sometime after the original establishment of cosmopolitan dog rabies and North American raccoon rabies (phylogenetically, the mongoose variant seems to be closer to the cosmopolitan variant than to the raccoon variant). Presumably, this would mean that a bat variant of rabies virus, with ancestral links to the European progenitor, would have to have been present in southern Africa a few centuries ago. If this is the case, the bat virus itself must have become extinct in southern Africa, since there is no evidence of rabies in bats in southern Africa, or anywhere on the African continent. Assuming that there are no extant true rabies viruses in African or other Old World bats, it has to be considered unlikely that a well established bat rabies virus would have become extinct in a stable reservoir(s) during the recent past. (2) Introduction of terrestrial mongoose rabies into southern Africa at some time before the dissemination of the cosmopolitan variant. However, given the efficiency with which dog rabies has manifested in dogs and a huge variety of wildlife during the past 50 years, the mongoose virus is unlikely to ever have been a dog virus, given the specificity and adaptation of this virus for species of the *Herpestidae* and its tendency to cause dead-end infections in other hosts, including canids. If this is the case, it would constitute a very different scenario from rabies in mongooses in the Caribbean. These mongooses were imported into the Caribbean from India in the 1870's and 1880's and genetic analysis indicate that these mongooses acquired cosmopolitan dog rabies from endemically infected Caribbean dogs, resulting in a first major mongoose rabies outbreak in 1950. Globally, the epizootiology of rabies in mongooses is poorly understood, outside of southern Africa and the secondary foci in the Caribbean.

- (4) As an established rabies epidemiology facility in southern Africa, we continue to be involved with research activities related to the radiation of rabies into and through the animals of our region. In our investigations of the canid rabies virus of southern Africa, we have recently focused on the molecular epidemiology of the ongoing dog rabies epidemic in Kwazulu/Natal. For the first time we have obtained a picture of the viruses involved and their movement within and among the municipal areas of this province. Our research indicated that, contrary to traditional belief, there may have been multiple introductions of rabies virus into the province, with implication for the future control of rabies in this province and elsewhere in southern Africa. One of these introductions may have been from a virus cycle associated with jackal and dog cycles. Whereas the importance of dogs as rabies hosts throughout Africa is without question, the role of jackals as important hosts is controversial. With regard to the transmission of rabies, it is only in southern Africa that jackals are considered to be important hosts of the virus. Some studies have indicated that they are able to support rabies cycles independently of dogs, while others contradict this finding. It is clear that the mechanisms involved in sustaining rabies in African canids are not yet understood. As our contribution, we are expanding our molecular epidemiological data from Kwazulu/Natal in 3 directions: (1) by inclusion of virus cycles towards the north, including Mpumalanga and Northern Province (2) by inclusion of viruses from neighbouring countries, Lesotho, Swaziland and Mozambique and (3) by inclusion of virus cycles associated with the Eastern Cape Province (where the first documented outbreak of rabies in South Africa occurred in 1893). (4) In other regions, the bat eared fox emerged as maintenance host for canid rabies. In this case, we were able to demonstrate the autonomy of these cycles and the independent evolution of the viruses involved.

## **B: Lyssavirus vaccines**

Oral vaccination of free-roaming and feral dogs will be a major step in the struggle to control

rabies in Africa. Despite the effective use of oral vaccines to vaccinate wildlife in Europe and Northern America, current oral vaccines (designed for wildlife - attenuated or classic poxvirus recombinant) are not appropriate for application in sub-Saharan Africa. The main problems are relative instability of some vaccines, or the potential danger of others, given the very high incidence of immunodeficiency in the resident human populations, primarily through the AIDS pandemic in the subcontinent. For various related reasons, the use of these classic pox recombinants has also been met with increasing resistance in the developed world. In this regard, a replication-deficient recombinant poxvirus expressing the relevant antigens may provide not only an effective vaccine but also a safer alternative to the currently available recombinant oral vaccines. Several such candidate vaccines (based on recombinant LSDV and MVA) have been constructed and evaluated in rodent and canine laboratory models. In addition, the generation of lyssavirus vaccines with an expanded range of effectiveness is a worthwhile objective. Combined or cross-reactive vaccines would be of obvious specific benefit to laboratory diagnosticians worldwide and to high-risk groups in those areas where nonrabies lyssaviruses are endemic. We have studied the cross-protective and cross-reactive responses elicited by DNA vaccines and recombinant vaccinia viruses expressing rabies, Mokola and/or West Caucasian bat virus glycoprotein genes either in single or in dual combinations. Our evidence suggest that a recombinant vaccine expressing rabies and Mokola virus glycoprotein is most likely to protect against the spectrum of lyssaviruses, but excluding West Caucasian bat virus (of which only a single bat isolate is known).

### **C: West Nile virus**

There has been a recent explosion in interest in this virus following its introduction and extraordinary spread throughout northern America. West Nile Virus is highly endemic in South Africa, but surveillance is very poor. The development of highly sensitive serological tests for WNV that can be safely produced on large scale will be of great value for diagnosis and surveillance of WNV activity in South Africa and elsewhere. Such tests may be used to answer important epidemiological questions regarding WNV associated morbidity in humans, ostrich chicks and horses and the association with neurological disease in South Africa.

### **D: Plant viruses**

Other than the proposed research on rhabdoviruses of plants, insects and animals – we are involved with a number of different plant virus programmes. These are (1) establishing a citrus virus diagnostic capability (2) studies on the epidemiology of grapevine leafroll disease, and (3) BSV incidence and transmission in South Africa. Pro-active strategies to prevent the introduction of plant viruses to new plantings and new areas are amongst the most efficient control methods for plant virus-induced diseases as it is very difficult and expensive to control them once they are already present. Foremost amongst these strategies are phytosanitary regulations and certification schemes, both of which ensure that healthy status of propagation material. To ensure that these strategies continued in the local citrus industry after the retirement of Dr. Fanie van Vuuren, formerly plant virologist at the ARC-Institute for Tropical and Subtropical Crops (ARC-ITSC), the South African Citrus Growers Association (CGA) via Citrus Research International (CRI) established a Plant Virology program in 2004 in collaboration with the Microbiology and Plant Pathology Department of the University of Pretoria (UP). This is housed at UP as part of the larger virology laboratory and is known as CRI@UP.

The primary research of the plant virology program is directed at support of the South African Citrus Improvement Program (CIP) as well as the Wine Grape Certification scheme. Winetech, the wine industry research co-ordinating body, supports the grapevine research component financially. In both schemes virus control plays a central role, with citrus tristeza virus (CTV) being the most important virus in the citrus scheme, and Grapevine leafroll associated virus type 3 (GLRaV-3), the most important one for the wine grape scheme. Both of these viruses belong

to the *Closteroviridae* family but CTV is in the *Closterovirus* genus and is aphid transmissible, while GLRaV-3 is in the genus *Ampelovirus* and is mealybug-transmissible. The differences in mode of transmission require that the respective certification schemes employ different strategies for control of these viruses. As CTV is easily and rapidly transmissible by highly mobile aphid vectors, citrus material from which viruses have been eliminated are protected against CTV infection in the field through the pre-inoculation of planting material with mild CTV strains. In contrast with this, wine grape material is subjected to virus elimination techniques and then propagated under conditions to minimize re-infection. This approach is possible as the re-infection takes place relatively slowly as mealybugs are generally sessile and it is possible to provide essentially “virus-free” propagation grapevine material. Neither strategy is foolproof. In citrus the cross protection by mild CTV strains is not always durable and severe CTV symptoms may occur with time. In grapevines on the other hand, the certified planting material is often re-infected by GLRAV-3 when healthy planting material is established in the field.

Research projects at **CRI@UP** are directed at doing basic and applied studies to understand and control 1) the occasional lack of CTV cross protection durability, 2) GLRaV-3 re-infection of certified material, and 3) improving methods to detect graft-transmissible pathogens of citrus and grapevines for improved quarantine and pathogen elimination with the certification schemes. With these objectives in mind four MSc. students are involved in studying aspects of the above; 1) Katherine Stewart has been establishing techniques to differentiate CTV strains in order to study the dynamics of CTV strains within the mild strain cross protecting populations under different environmental conditions, 2) Orienka Koch is identifying pathogens spreading within certified material of the wine grape certification scheme, 3) Aletta Kotze is studying GLRaV-3 variability in order to develop molecular markers with which to monitor the spread of the virus in vineyards, and 4) Baby Phahladira is developing a protocol for the detection of “Candidatus” *Liberibacter africanus*, the causal organism of African greening of citrus and studying the potential of other hosts involved. Gerhard Pietersen is study leader to all of the above and is also busy establishing a comprehensive diagnostic capability to the graft-transmissible pathogens of citrus, and is studying the epidemiology of GLRaV-3 in the wine grape certification scheme.

In support of the banana industry, Jacolene Meyer has done studies to determine whether banana streak virus (BSV), when present as an endogenous virus in B-genome bananas, can be transmitted by mealybug vectors once activated to become an episomal virus. These findings are very important in quantifying risks associated with the tissue culture propagation and dissemination of banana plantlets.



Members of the plant virus research group



### Visits from international guests

We were fortunate to have been able to welcome a number of international collaborators and guests to our shores during 2006.

#### **Dr. Alex Wandeler (Canada)**

During January 2006 Dr. Alex Wandeler of the Canadian Food Inspection Agency, Canada, visited our research group. Dr. Wandeler is an internationally recognized expert in lyssavirus research and heads up the WHO collaborating centre and the OIE reference centre at the CFIA in Ottawa, Ontario. During his visit he also presented a training course covering rabies diagnostic methods at the Onderstepoort Veterinary Institute (OVI). A number of students from our laboratory also participated in this course.



#### Lyssavirus diagnostic course:

Back row: Dr. Shumba (OVI), Wanda Markotter (UP), Nicolette van Zyl (UP), Dr. Wandeler, Peter Coetzee (UP), Dr. Sabeta (OVI). Front row: Ernest Ngoepe (OVI/UP), Jacqueline Weyer (UP), Gugulethu Zulu (OVI/UP), Deborah (OVI), Nantu Phalatsi (UP)

#### **Dr. Charles Rupprecht (CDC, USA)**

Dr. Charles Rupprecht, Head of the CDC rabies unit and Director of the World Health Reference Centre for rabies research, visited our research group during June 2006. During his visit we went on a surveillance field trip towards Duvenhage virus surveillance, in collaboration with the National Institute for Communicable Diseases (NICD). This puzzling and obscure lyssavirus was responsible for a human fatality earlier in the year and we visited the general area associated with the virus, in the North West province of South Africa. At the NICD Dr Rupprecht presented a talk on global issues of rabies. Subsequently, we have traveled to Kwazulu Natal (KZN), where we visited our collaborators at the Directorate of Veterinary Services, Allerton, Pietermaritzburg. We have studied the molecular epidemiology of the dog rabies epidemic in KZN during the recent past and hope to contribute to improved control efforts that may include the use of new generation oral vaccines. Later, we met with the KZN bat interest group in Durban, another important collaborator of our group. Here, our focus was on our interest in the lyssaviruses of bats, considering that all of our Lagos bat virus isolates originated from within KZN.



Duvenhage virus surveillance: left to right – Louis, Jan, Janusz, Chuck, Danielle and Wanda

Drs Charles Rupprecht (CDC, USA) and Janusz Paweska (NICD, SA) at the property where the first human fatality due to a rabies-related virus, viz. Duvenhage virus, occurred in 1970. The car belonged to the victim, Mr Duvenhage.



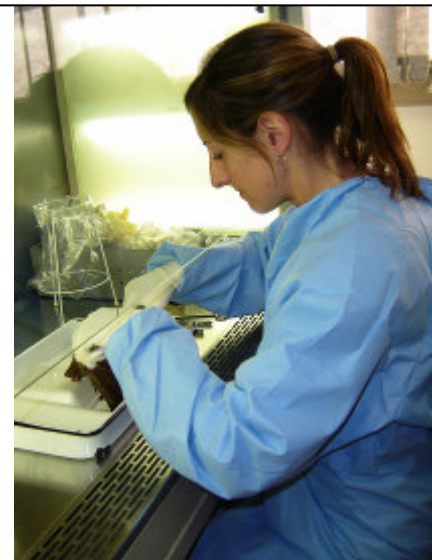
### Danielle Davignon (USA)

Danielle Davignon, a final year veterinary student from Wisconsin, USA, spent a month as part of a Hubert fellowship with our research group. During this time she was involved in field surveillance of bats for lyssaviruses, laboratory diagnosis of rabies in bats and spent time with the SPCA in Durban assisting in vaccination campaigns for rabies in rural areas.



Danielle Davignon (USA), Dr. Janusz Paweska (NICD), Pat Lemann (NICD) and Wanda Markotter (UP) at the house where Mr Duvenhage was in 1970 exposed to the virus that turned out to be the type member of a new lyssavirus genotype.

Danielle vaccinating a dog in rural Kwazulu Natal.



Danielle dissecting a bat before testing the brain for the presence of lyssavirus antigens

### Dr. Noël Tordo (Pasteur Institute, France)

This was a long planned informal visit from Dr Noël Tordo and his two daughters, Jade and Maiva. Apart from discussions with members of the virology group, the Tordo's have visited Kwazulu Natal as well as the Lowveld with us. The three of them also explored various museums independently. It was great to have these true Parisians with us.



Dr. Noël Tordo with his daughters visiting South Africa

### Prof. J. Bové (INRA, France)

Prof. Bové, arguably the world authority on Citrus greening disease joined staff of [CRI@UP](#) and CRI in late November, early December on a collection trip to obtain greening infected citrus trees throughout South Africa. These samples will be analysed for the presence of known *Liberibacter* species as well as a determination of the variability of *Liberibacter africanus* locally.

### Dr. P. Yamamoto (Fundecitrus, Brazil)

Dr. Yamamoto, an entomologist working on the psyllid vector of greening at Fundecitrus in Brazil (*Diaphorina citri*), also took part during the greening collection trip. He was most interested in observing differences between African greening transmitted by the psyllid *Trioza erytrea* and the two greening causal organisms transmitted by *Diaphorina citri* in Brazil.

### Dr. S. Lopes (Fundecitrus, Brazil)

Dr. Lopez, a plant virologist working on numerous aspects of greening control and transmission at Fundecitrus in Brazil also took part in the greening collection trip in November/December. Doing very similar work to that envisaged at [CRI@UP](#), a lot of excellent dialogue was held with Dr. Lopes and ties strengthened to ensure future collaboration.





The survey for greening drew together a great group of collaborators from all of the world. In picture in a citrus orchard are from left to right; Dr. Fanie van Vuuren (CRI, formerly from ARC-ITSC), Prof. J. Bove' (INRA, France), Prof. Gerhard Pietersen (CRI and UP), Jacolene Meyer (UP, du Roi, CRI), Dr. Silvio Lopes (Fundecitrus, Brazil) and Dr. Pedro Yamamoto (Fundecitrus, Brazil).

### **International research visits**

During 2006 Wanda Markotter (PhD studies) and Nantu Phalatsi (MSc studies) visited the



Centers for Disease Control and Prevention, Rabies Unit on separate research visits to complete part of their post graduate studies. Wanda performed research investigating the epidemiology and pathogenesis of Lagos bat lyssavirus. This lyssavirus causes rabies encephalitis in fruit eating bats in Africa and current rabies vaccines do not provide protection. Nantu analyzed the efficiency of DNA vaccines for lyssaviruses in animal models at this facility.

The CDC rabies research

### **International conferences: Organizing and participation**

#### **The 9<sup>th</sup> Annual Conference on Vaccine Research.**

Baltimore, United States of America, 8-10 May 2006.

Jacqueline Weyer presented a poster entitled "Cross-reactive and cross-protective immune responses to recombinant vaccinia viruses expressing full-length lyssavirus glycoprotein genes"

#### **The 8<sup>th</sup> Meeting of the Southern and Eastern African Rabies Group (SEARG).**

Heja Game Lodge, Windhoek, Namibia, 22- 26 January 2006

Our group organized this meeting and, apart from Conference Chair and related functions, a number of the formal paper presentations were from our laboratory:

- Jacqueline Weyer: Rabies vaccination: Future trends
- Nantu Phalatsi: DNA vaccines for rabies: an Overview
- Nicolette van Zyl: RABNET: The value of a global network for Rabies
- Wanda Markotter: Molecular epidemiology and characterization of Lagos bat virus isolates from South Africa
- Wanda Markotter: Classical rabies diagnostics and new developments
- Louis Nel: Non-rabies lyssaviruses from Africa: the status quo
- Peter Coetzee: Molecular phylogeny of canine rabies in KwaZulu Natal



Conference delegates at the SEARG meeting: Wanda Markotter (UP), Dr. Alex Wandeler (Canada), Prof. Louis Nel (UP), Dr. Peter Taylor (Durban Science museum), Dr. Claude Sabeta (OVI) and Dr. Tony Fooks (UK).

Students of our research group attending the conference: Wanda Markotter, Jacqueline Weyer, Nantu Phalatsi, Ernest Ngoepe, Peter Coetzee, Liz Botha and Nicolette van Zyl.





## 13th International Conference on Negative Strand RNA Viruses

17-22 June 2006, Salamanca, Spain

Salamanca is a historic Spanish university town. The architecture is breathtaking and the meeting itself was excellent. Apart from being well-



organized and including quality social events and classical shows, the level of the scientific contributions at these meetings are very high indeed. Our presentation (Nel et al) was entitled: New aspects of the epidemiology and control of rabies and rabies related viruses in South Africa. Other well-known lyssavirologists at this meeting included Dr's Schnell (USA), Tordo (France), Johnson (UK) and Nadin-Davis (Canada).

## 15<sup>th</sup> Meeting of the International Council for the Study of Virus and Virus-like diseases of the Grapevine

3-7 April 2006, Stellenbosch, South Africa

Prof. Pietersen was on the Organising Committee of this very successful conference, which some 140 delegates from 24 countries attended. Our MSc students Aletta Kotze and Orienka Koch both attended the conference.

The following was presented at this conference by Prof. Pietersen:

- Use of remote sensing to monitor the spread of grapevine leafroll disease in South Africa.
- Rapid identification of three mealybug species by multiplex PCR (This paper was presented by Dr.

Pietersen's collaborator, Dr. K. Krugër (Department of Zoology, UP).

- Spatio-temporal distribution dynamics of grapevine leafroll disease in Western Cape vineyards.
- Vergelegen, South Africa; a case study of an integrated control strategy to prevent the spread of grapevine leafroll disease.



Orienka Koch (left) and Aletta Kotze (right) in festive mood with Prof. G. Martelli (the father of grapevine virus disease research).

## **XVII Acorbat International Meeting**

15-20 October 2006, Joinville, Brazil

Neither Prof.s Pietersen, Nel nor Jacolene Meyer could attend the conference personally because of prior commitments but requested that Dr. John Robinson presented the invited paper for them.

Presentation by Dr. John Robinson for Prof. Pietersen, Nel and Me. Meyer

“Transmission studies of activated-episomal banana streak badnavirus from FHIA-21 (AAAB) by four mealybug species”

## **Huanglongbing-greening International Workshop**

16-20 July, Ribeirao Preto, Brazil.



This workshop, to discuss all aspects of huanglongbing/Greening was attended by experts from throughout the world. Renewed interest in this disease has been generated due to its introduction Brazil and now to the United States of America as well. It was attended by Prof. Pietersen who was supported financially by CRI.

Monitoring for citrus greening disease in Brazil.

## **17<sup>th</sup> International Rabies in the Americas meeting**

15-20 October 2006, Brasilia, Brazil.



Prof Nel presented two papers at this meeting viz (1) Recent epidemiology of southern African lyssaviruses and (2) Rabies and its control in Kwazulu-Natal, South Africa.

Brasilia is the capital of Brazil and a most interesting city – founded less than 50 years ago. It was originally planned for 200 000 people (mostly government employees) but the population has

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quickly ballooned to more than 2mill. The annual RITA meeting is the most important lyssavirus-specific meeting on the calendar and this, the 2006 meeting, was the largest to date. The 2007 meeting is planned for Mexico.

### 3<sup>rd</sup> International Enology and Viticulture Conference

14-17 November, 2006, Somerset West, South Africa.

Prof. Pietersen attended this conference and presented a paper, "An integrated control strategy to prevent the spread of grapevine leafroll disease on Vergelegen wine estate – a model for the South African wine industry.

### **National conference participation.**

44th Congress of the South African Society for Plant Pathology Magalies Park Country Club 22-25 January, 2006.

Prof. Pietersen was invited to present the Van der Planck Memorial lecture at this conference, where he discussed the past ten years research conducted by his group on the epidemiology and control of grapevine leaf roll disease in South Africa in a talk titled: "Tackling the grapevine leafroll disease problem in South Africa"

Three MSc students of the virology group attended the conference namely Jacolene Meyer, Katherine Stewart and Zama Dlamini.

Further papers presented:

- Jacolene Meyer: Evaluation of the efficiency of four mealybug species to transmit activated-episomal Banana streak badnavirus.
- Katherine Stewart: Dynamics and molecular characterisation of citrus tristeza virus (CTV) strains within South African GFMS12 cross-protecting population.

### 4<sup>th</sup> Citrus Research Symposium

Port Elizabeth, 20-23 August, 2006.

This conference on all aspects of Citriculture, was attended by Prof. Pietersen, and two MSc. Students, Me. Katherine Stewart and Me. Baby Phahladira

The following was presented:

- Prof. Gerhard Pietersen: Progress towards establishment of a comprehensive diagnostic capacity at CRI against citrus graft-transmissible pathogens
- Katherine Stewart: Development and implementation of PCR and microarray-based methods to differentiate citrus tristeza virus (CTV) strains.

### **Field work and other activities.**

#### **Gauteng and Northern Regions Bat Interest Group (July 2006)**

At a meeting in the Discovery centre of the University of Pretoria, Prof. Nel presented a talk to the Gauteng and Northern Regions Bat Interest Group. The theme that we focused on was: 'Bats and emerging viruses: Who is at risk?' This provided an overview of the scientific knowledge on viruses in bats and the implications for zoonoses and emerging zoonoses. Our meeting also provided an opportunity to inform regular bat handlers about the risks involved and

how to minimize these as well to rediscover common interests and to re-enforce future collaborations.

### **Vaalwater – Bela-Bela**

The purpose of this field trip on 14-15 July was surveillance for Duvenhage virus, one of the uniquely African lyssaviruses. We tried to identify locations where it would be possible to capture bat species implicated in the epidemiology of the disease. These surveillance efforts are done in collaboration with the Special Pathogens Unit at the NICD in Johannesburg. Dr. Rupprecht and Danielle Davignon from the USA also accompanied us.



Dr. Janusz Paweska (NICD), Alan Kemp (NICD), Dr. Charles Rupprecht (USA), Prof. Louis. Nel (UP), Wanda Markotter (UP) and Pat Lemann (NICD) busy setting up nets to capture

### **Thabapashwa, Potgietersrus**

Jacqueline Weyer and Wanda Markotter attended a group outing of the Gauteng and Northern Regions Bat Interest Group (GNOR BIG) from 20-22 October to the Thabaphaswa area just outside of Potgietersrus (now Mokopane), Limpopo Province. The weekend was spent trying to catch bats in mist nests as well with a “harp trap”, and then subsequently identifying the bats. Wing web biopsies were also collected to aid in the identification of some specimens through molecular methods.

### **Paarl, Western Cape**

A field trip was conducted in February, 2006 to monitor mealybugs in a Vineyard in Paarl, Western Cape in which a long-term trial is being conducted to compare the efficacy of fallow periods as opposed to systemic insecticide/herbicide treatment has on transmission of grapevine leafroll disease between successive vineyards planted on the same site.

### **Vergelegen, Western Cape**

During April-May, 30 vineyards were monitored in the western Cape for leafroll spread as part of an ongoing study into the spatio-temporal spread of grapevine leafroll disease. Studies were also conducted in this period on Vergelegen, where strategies to achieve leafroll eradication are being applied. The first wines from these virus-free vineyards are of an excellent quality, and Vergelegen winemaker, Andre’ van Rensburg was awarded the “Platter Wine of the Year”



award for a wine from one of these vineyards.

### **Komati River Gorge, Machadodorp**

Jacqueline Weyer and Wanda Markotter attended a group outing of the Gauteng and Northern Regions Bat Interest Group (GNOR BIG) from 10-12 November to the Komati River Gorge nearby Machadodorp, Mpumalanga. The weekend was spent trying to catch bats in mist nests as well with a “harp trap”, and then subsequently identifying the bats. Wing web biopsies were also collected to aid in the identification of some specimens through molecular methods.



Wanda Markotter and Jacqueline Weyer collecting samples together with Nigel Fernsby (President of the GNOR-BIG)

### **Awards and recognition**

**Jacqueline Weyer** received her PhD titled “Immune responses to recombinant poxviruses expressing full-length lyssavirus glycoprotein genes” in May 2006. She was an International Travel Grant Award recipient to the 9<sup>th</sup> Annual Conference on Vaccine Research. The conference was sponsored by the National Foundation of Infectious Diseases and was hosted in Baltimore, United States of America on the 8-10 May 2006.

**Jacqueline Weyer** also received an L’Oréal-UNESCO PhD fellowship award for academic excellence during the 2006 L’Oréal-Unesco Women in Science Awards ceremonies.



Jacqueline receiving her award from the Minister of Science and Technology, Mosibudi Mangena and the managing director of L’Oréal, South Africa, Mr Dave St Quintin



**Nantu Phalatsi** received a Travel Grant from the International students office of the University of Pretoria to visit the CDC in Atlanta USA

**Katherine Stewart** and **Orienka Koch** received prestigious PhD bursaries from the NRF.

**Katherine Stewart** was awarded the Best Speaker Award at the 4<sup>th</sup> Citrus Research Symposium, in

Port Elizabeth, 20-23 August, 2006

**Baby Phaladira** received a DST Transformation and Capacity Building Award. This award aims to increase the number of African scientists through mentorship of the particular research field and to implement and develop leadership and management skills to the awardees.

### Employment

**Jacolene Meyer**, was seconded to CRI, Nelspruit by du Roi Laboratories to set up diagnostic tests and to provide this as a service on tissue culture banana plantlets. Part of here time is also utilized by CRI in doing research on greening disease of citrus.

**Nantu Phalatsi** was employed as an Applied Science Training Consultant at Roche (1 November 2006)

**Peter Coetzee** was employed as a Medical Scientist, Polio Division, National Institute for Communicable Diseases (October 2006)

**Jacqueline Weyer** has been offered the position of Senior Medical Scientist, Special Pathogens Unit, National Institute for Communicable Diseases (January 2007).

### Students graduating 2006

Peter Coetzee (MSc Cum Laude: Prof Nel)

Jacolene B Meyer (MSc Cum Laude: Proffs Nel, Pietersen)

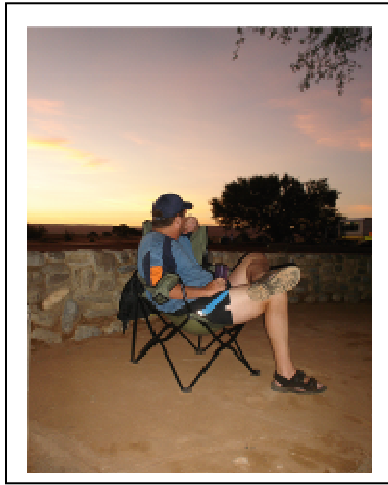
Orienka Koch (MSc: Proffs Pietersen, Nel)

Jacqueline Weyer (PhD: Prof Nel)

### Lab outings

#### **Namibia**

During January 2006 members of the laboratory went on a road trip from Pretoria, *via* Botswana to Windhoek, Namibia, and *via* the Fish River Canyon back to Pretoria. The trip proved to be very memorable, and also marked the first "Out of SA" trip for some of our students. As part of the trip we stayed over in the following places: Kang (Botswana); Windhoek (Nam); Swakopmund (Nam); Sesriem, Sossusvlei (Nam) and Ais-Ais, Fish River Canyon (Nam).



Prof Nel in a pensive



Left: Prof Nel, Nicolette van Zyl, Jackie Weyer, Nantu Phalatsi and Liz Botha at Sossusvlei;  
Top: Students trying to cross a “flashflood” river

### Nylsvlei weekend

During the weekend of the 24-26th November 2006 we visited Nylsvlei Nature Reserve, Limpopo Province as our group year-end function. Nylsvlei is recognized as the habitat for an immense variety of waterfowl and other birdlife and is one of our few UNESCO world heritage sites. We were fortunate to have Michael Poll of the South African Astronomy Association with us. He presented a talk on astronomy, and guided us in around the night skies by eye and by telescope.



Prof Pietersen teaching Katherine Stewart how to identify the tree

Members of our group giving closer inspection to a tree



Prof Nel, Prof Pietersen and Renate Lambrecht

### Tswaing Crater experience

Forty kilometers north of Pretoria nearby Soshanguwe, lies a ring of hills a kilometer in diameter and 100 meters high. These hills are the walls of an impact crater left by an asteroid which hit there some 200 000 years ago. Towards the end of 2005, the members of the laboratory visited this Tswaing Crater site. The trip included a guided walk to the crater site and allowed us to, during the 2006 visit of some of our international guests, provide our own guided tours of this unique and magnificent site.



The Virology research group of 2005 visiting the crater

### Peer reviewed publications of 2005 and 2006

BRIGGS, D., BOURHY, H., CLEAVELAND, S., CLIQUET, F., ERTL, H., FAYAZ, A., FOOKS, A., HEMACHUDHA, T., ICHHPUJANI, R.L., KABOYO, W.R., KOPROWSKI, H., MADHUSUDANA, S.N., MULLER, T., **NEL, L.**, QUIAMBAO, B., RUPPRECHT, C.E., SALAHUDDIN, N., SUDARSHAN, M.K., TORDO, N., WANDELER, A.I., WILDE, H., CLIQUET, F., SPINOLA, F., BELOTTO, A., BHATIA, R., ENDO, H., GANTER, B., GIBERT, R., GRACHEV, V., KNEZEVIC, I., MC ADAMS, D., MESLIN, F.-X., MIRANDA, E., MORGEAUX, S., ROUNGOU, J.-B. 2005. WHO expert consultation on rabies. World Health Organization - Technical Report Series, (931), pp. i-viii+1-85.

CLOETE, T.E., **NEL, L.H.**, & THERON, J. 2006. Biotechnology in South Africa. Trends in Biotechnology, 24:557-562.

MANSFIELD, K., MCELHINNEY, L., HUBSCHLE, O., METTLER, F., SABETA, CT., **NEL, LH.** AND FOOKS, AR 2006. A molecular epidemiological study of rabies epizootics in kudu (*Tragelaphus strepsiceros*) in Namibia. BMC Veterinary research, 13; 2 (1):2.

**MARKOTTER, W**, RANGLES, RUPPRECHT, CE, SABETA, CT, WANDELER AI, TAYLOR PJ and **NEL LH.** 2006. Recent Lagos bat virus isolations from bats (suborder Megachiroptera) in South Africa. Emerging Infectious Diseases, Vol 12 (3) pp 504-506.

**MARKOTTER W**, KUZMIN I, RUPPRECHT CE, RANGLES J, SABETA CT, WANDELER AI, **NEL LH.** 2006. Isolation of Lagos bat virus from water mongoose. Emerg Infect Dis. 2006; 12(12): 1913-1918.

**NEL, LH.**, SABETA, CT., VON TEICHMAN, B., JAFTHA, J.B., RUPPRECHT, CE. AND BINGHAM, J. 2005. Mongoose rabies in southern Africa: a re-evaluation based on molecular epidemiology. Virus Research, Vol 109 (2) pp 165-173.

**NEL, LH.** 2005. Vaccines for lyssaviruses other than rabies. Expert Reviews of Vaccines, Vol 4 (4) pp 533-540.

**NEL, L.H.** & RUPPRECHT, C.E. 2006 "Emergence of lyssaviruses in the old world: The case of Africa". In: Current Topics in Microbiology and Immunology special volume "RECENT EXPERIENCES WITH EMERGING DISEASES. Volume 1: The role of wildlife in disease emergence. C: Case studies in Zoonotic Disease Emergence: Chapter 10: Lyssaviruses". J Childs (ed) Springer-Verlag

PAWESKA, J.T., BLUMBERG, L.H., LIEBENBERG, C., HEWLETT, R.H., GROBBELAAR, A.A., LEMAN, P.A., CROFT, J.E., **NEL, L.H.**, NUTT, L., & SWANEPOEL, R. 2006. Fatal rabies-related Duvenhage virus infection in South Africa. Emerging Infectious Diseases, 12(12):1965-1967

VILJOEN, G.J., CROWTHER, J & **NEL, L.H.**, (Authors). 2005 "Molecular Diagnostic PCR Handbook. Springer, Dordrecht, The Netherlands. 307 pages ISBN 1-4020-3403-2.

# PUBLICATIONS IN SCIENCE CITATION INDEX JOURNALS

1. **ADANDONON, A., AVELING, T.A.S., LABUSCHAGNE, N. AND TAMO, M.** (2006). Biocontrol agents in combination with *Moringa oleifera* extract for integrated control of *Sclerotium*-caused cowpea damping-off and stem rot. *European Journal of Plant Pathology*
2. **ATHMAN, S.Y., DUBOIS, T., VILJOEN, A., LABUSCHAGNE, N., COYNE, N., RAGAMA, P., GOLD, C.S. AND NIERE, B.** *In vitro* antagonism of endophytic *Fusarium oxysporum* isolates against the burrowing nematode *Radopholus similis*. *Nematology*, 2006, Vol. 8(4), 627-636.
3. **BAIMEY, H., COYNE, D. AND LABUSCHAGNE, N.** (2006). Effect of fertiliser application on yam nematode (*Scutellonema bradys*) multiplication and consequent damage to yam (*Dioscorea* spp.) under field and storage conditions in Benin. *International Journal of Pest Management*, 52(1): 63-70.
4. **BRIGGS, D., BOURHY, H., CLEAVELAND, S., CLIQUET, F., ERTL, H., FAYAZ, A., FOOKS, A., HEMACHUDHA, T., ICHHPUJANI, R.L., KABOYO, W.R., KOPROWSKI, H., MADHUSUDANA, S.N., MULLER, T., NEL, L., QUIAMBAO, B., RUPPRECHT, C.E., SALAHUDDIN, N., SUDARSHAN, M.K., TORDO, N., WANDELER, A.I., WILDE, H., CLIQUET, F., SPINOLA, F., BELOTTO, A., BHATIA, R., ENDO, H., GANTER, B., GIBERT, R., GRACHEV, V., KNEZEVIC, I., MC ADAMS, D., MESLIN, F.-X., MIRANDA, E., MORGEAUX, S., ROUNGOU, J.-B.** WHO expert consultation on rabies (2005) *World Health Organization - Technical Report Series*, (931), pp. i-viii+1-85.
5. **CLOETE, T.E., NEL, L.H. AND THERON, J.** (2006). Biotechnology in South Africa. Trends in Biotechnology; Vol 24 No 12 doi:10.1016/j.tibtech. 2006.10.009
6. **COETSER, S.E., PULLES, W., HEATH, R. and CLOETE, T.E.** 2006. Chemical characterization of organic electron donors for sulfate reduction for potential use in Acid mine drainage treatment. *Biodegradation*. 17 (2): 67-77
7. **COYNE, D.L., TCHABI, A., BAIMEY, H., LABUSCHAGNE, N. AND ROTIFA, I.** Distribution and prevalence of nematodes (*Scutellonema bradys* and *Meloidogyne* spp.) on marketed yam (*Dioscorea* spp.) in West Africa. *Field Crops Research* 96 (2006) 142-150.
8. **DEMOZ, B.T. and KORSTEN, L.** 2006. *Bacillus subtilis* attachment, colonization and survival on avocado flowers and its mode of action on stem-end rot pathogens. *Biological Control* 37: 68-74.
9. **DU PLOOY, W., VAN DER MERWE, C. and KORSTEN, L.** 2006. Lenticel discolouration of mango (*Mangifera indica* L.) fruit -Cytological study of mesophyll cells from affected tissue. *Journal of Horticultural Science & Biotechnology* 81(5): 869-873.
10. **FOUCHE-WEICH J, POUSSIER S, TRIGALET-DEMERY D, BERGER D, COUTINHO TA,** 2006. Molecular identification of some African strains of *Ralstonia solanacearum* from *Eucalyptus* and potato. *Journal of General Plant Pathology* 72.
11. **GOSZCZYNSKA T, MOLOTO VM, VENTER SN, COUTINHO TA,** 2006. Isolation and identification of *Pantoea ananatis* from onion seed in South Africa. *Seed Science and Technology*, 34:677-690.
12. **GOSZCZYNSKA T, VENTER SN, COUTINHO TA,** 2006. PA 20, a semiselective medium for isolation and enumeration of *Pantoea ananatis*. *Journal of Microbiological Methods*, 64:225-231.
13. **GOVENDER, V. and KORSTEN, L.** 2006. Evaluation of different formulations of *Bacillus licheniformis* in mango packhouse trials. *Biological Control* 37:237-242.



14. **GROENEWALD, S., VAN DEN BERG, N., MARASAS, W.F.O. AND VILJOEN, A.** 2006. The application of high-throughput amplified fragment length polymorphisms in assessing genetic diversity in *Fusarium oxysporum* f.sp. *cubense*. *Mycological Research* 110: 297-305.
15. **GROENEWALD, S., VAN DEN BERG, N., MARASAS, W.F.O. AND VILJOEN, A.** 2006. Biological, Physiological and Pathogenic variation in a genetically homogenous population of *Fusarium oxysporum* f.sp. *cubense*. *Australasian Plant Pathology* 35: 401-409.
16. **KAISER, C., V.D. MERWE, R., BEKKER, T.F. AND LABUSCHAGNE, N.** (2006). *In-vitro* inhibition of mycelial growth of several phytopathogenic fungi by soluble potassium silicate. *S. Afr. J. Plant Soil* 2006, 23(3) 169-172.
17. **KAREN MANSFIELD, LORRAINE MCELHINNEY, OTTO HUBSCHLE, FELIX METTLER, CLAUDE SABETA, LOUIS H. NEL AND ANTHONY R. FOOKS.** 2006. A molecular epidemiological study of rabies epizootics in kudu (*Tragelaphus strepsiceros*) in Namibia. *BMC Veterinary research*, 13; 2 (1):2.
18. **KORSTEN, L.** 2006. Advances in control of postharvest diseases in tropical fresh produce. *Int. J. Postharvest Technology and Innovation* 1(1): 48-61.
19. **MAILA MP, RANDIMA P, DRØNEN K AND CLOETE TE.** 2006. Soil Microbial Communities: Influence of geographic location and hydrocarbon pollutants. *Journal of Soil Biology & Biochemistry*. 38; 303-310.
20. **MARKOTTER W, KUZMIN I, RUPPRECHT CE, RANGLES J, SABETA CT, WANDELER AI, NEL LH.** 2006. Isolation of Lagos bat virus from water mongoose. *Emerg Infect Dis*. 2006: 12(12) 1913 – 1918.
21. **MARKOTTER, W., RANGLES, J., RUPPRECHT, C.E., SABETA, C.T., WANDELER, A.I., TAYLOR, P.J. and NEL, L.H.** 2006. Recent Lagos bat virus isolations from bats (suborder Megachiroptera) in South Africa. *Emerging Infectious Diseases*, Vol 12 (3) pp 504-506.
22. **MEYER, L., SANDERS, G.M., JACOBS, R. and KORSTEN, L.** 2006. A one-day sensitive method to detect and distinguish between the citrus black spot pathogen *Guignardia citricarpa* and the endophyte *Guignardia mangiferae*. *Plant Disease* 90: 97-101.
23. **MOMBA, M.N.B., MALAKATE, V.K. AND THERON, J.** (2006). Abundance of pathogenic *Escherichia coli*, *Salmonella typhimurium* and *Vibrio cholerae* in Nkonkobe drinking water sources. *Journal of Water and Health* 4, 289-296.
24. **MOOLMAN, F.S., LABUSCHAGNE, P.W., THANTSA, M.S., VAN DER MERWE, T.L., ROLFES, H. and CLOETE, T.E.** 2006. Encapsulating probiotics with an interpolymer complex in supercritical carbon dioxide. *South African Journal of Science* 102, July/August 2006, p 349-354.
25. **NEL, B., STEINBERG, C., LABUSCHAGNE, N. AND VILJOEN, A.** 2006. Isolation and characterization of non-pathogenic *Fusarium oxysporum* isolates from the rhizosphere of healthy banana plants. *Plant Pathology* 55: 207-216.
26. **NEL, B., STEINBERG, C., LABUSCHAGNE, N. AND VILJOEN, A.** 2006. The potential of non-pathogenic *Fusarium oxysporum* and other biological control organisms for suppression Fusarium wilt of banana. *Plant Pathology* 55: 217-223.
27. **OBERHOLSTER, P.J., BOTHA, A.M. and CLOETE, T.E.** 2006. Toxic cyanobacterial blooms in a shallow artificially mixed urban lake Colorado. USA. *Lakes & Reservoirs: Research and Management*, 11: 111-123.
28. **PAWESKA, J.T., BLUMBERG, L.H., LIEBENBERG, C., HEWLETT, R.H., GROBBELAAR, A.A., LEMAN, P.A., CROFT, J.E., NEL, L.H., NUTT, L. & SWANEPOEL, R.** 2006. Fatal rabies-related Duvenhage virus infection in South Africa. *Emerging Infectious Diseases*, 12 (12) 1961-1963.
29. **SIVAKUMAR, D. and KORSTEN, L.** 2006. Evaluation of integrated application of two types of modified atmosphere packaging and hot water treatments on the quality and retention of the litchi cultivar McLean's Red. *J. Hort. Sci. & Biotech.* 81: 639-644.
30. **SIVAKUMAR, D. and KORSTEN, L.** 2006. Influence of modified atmosphere packaging and postharvest treatments on quality retention of litchi cv. Mauritius. *Postharvest Biology and Technology* 41: 135-142.

31. **THANTSHA, M. and CLOETE, T.E.** 2006. The effect of sodium chloride and sodium bicarbonate derived anolytes, and anolyte-catholyte combination on biofilms. *Water SA*, Vol 32 No 2:237-242

## CONTRIBUTIONS IN PUBLISHED REFEREED CONFERENCE PROCEEDINGS

1. **PIETERSEN, G.** 2005. Spatial and temporal analysis of spread of grapevine leafroll disease in South Africa. IX International Plant Virus Epidemiology Symposium. Lima, Peru 4-7 April, 2005.
2. **SABETA, C. T., & NEL, L.H.,** 2005. Canid rabies in South Africa and Zimbabwe – a review. *Proceedings of the 7<sup>th</sup> Southern and Eastern African Rabies Group/World Health Organization Meeting*, Manzini, Swaziland. Editions Foundation Marcel, Merieux 17, rue Bourgelat, 69002 Lyon – France. pp 135-139.
3. **SAID, M.D., VENTER, S.N., BOOYSEN, I. AND CLOETE, T.E.** 2006. Health consequences of inadequate water service delivery: the case of the cholera epidemic in KwaZulu-Natal, South Africa. In: Young Researchers 2006. Eds: R Stuetz and L. Teik-Thye. IWA Publishing, London, 379 - 392.
4. **WEYER, J., VILJOEN, G. J., & NEL, L H.,** 2005. Alternative recombinant poxvirus vaccines for rabies. *Proceedings of the 7<sup>th</sup> Southern and Eastern African Rabies Group/World Health Organization Meeting*, Manzini, Swaziland. Editions Foundation Marcel, Merieux 17, rue Bourgelat, 69002 Lyon – France. pp 79-84.

## CHAPTERS IN REFEREED SPECIALIST BOOKS

1. **COUTINHO, T.A.** CABI International (2006) *Puccinia psidii* In: Crop protection compendium, edition. Wallingford, UK: CAB International.
2. **KORSTEN, L. & ZAGORY, D.** 2006. Microbial Hazard Identification in Fresh Fruit and Vegetables. Chapter 7 in: *Pathogen Survival on Fresh Fruit in Ocean Cargo and Warehouse Storage*. (Ed. J. James). Wiley & Sons. ISBN 0-471-67076-6.
3. **LABUSCHAGNE, N. & JOUBERT, D.** 2006. Profile Modification as a Means of Soil Improvement: Promoting Root Health through Deep Tillage. *Biological Approaches to Sustainable Soil Systems*, p547-558.
4. **SANDERS, G.M. & KORSTEN, L.** 2006. *Colletotrichum gloeosporioides*; an example of an important post harvest pathogen of subtropical fruits. Pp 868-881 in: Control of pests, diseases and disorders of crops. (Ed. Ramdane Dris). WFL Publishers, Helsinki. ISBN 952-91-8601-0.
5. **NEL, L.H. & RUPPRECHT, C.E.** "Emergence of lyssaviruses in the old world: The case of Africa". In: CTMI special volume "RECENT EXPERIENCES WITH EMERGING DISEASES. Volume 1: The role of wildlife in disease emergence. C: Case studies in Zoonotic Disease Emergence: Chapter 10: Lyssaviruses". J Childs (ed) Springer-Verlag, in press (2006).

## EDITOR OF BOOKS

1. **Prof J Theron**  
Proceedings of the Microscopy Society of Southern Africa, Volume 36, 2006: Medicine and Zoology Sections.

## BOOKS PUBLISHED

1. **Eugene Cloete and Ronald Atlas:**  
Basic and Applied Microbiology, Van Schaik publishers, 2006

## NATIONAL CONFERENCE CONTRIBUTIONS

### Invited speaker

1. **T.E. CLOETE.** Biotechnology frontiers in the 21<sup>st</sup> century. APRSSA Congress, October 2006, Drakensberg Conference Centre.
2. **T.E. CLOETE.** Chemical Control of Biofouling and Biocorrosion in Industrial Water Systems, The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9-12 April 2006.
3. **KORSTEN, L.** 2006. Addressing ethics in laboratories. SANAS assessor workshop. Kopanong Hotel, Benoni. 3-4 March 2006.
4. **PIETERSEN, G.,** 2006. (Keynote speaker). Tackling the grapevine leafroll disease problem in South Africa. The Dr JE VanderPlanck Memorial Address. Proceedings of the 44<sup>rd</sup> Congress of the South African Society for Plant Pathology. Magalies Park Country Club 22-25 January, 2006

### Papers

1. **COUTINHO TA, GOSZCZYNSKA T, VENTER SN,** 2006. Current status of phytobacteriology in South Africa. Proceedings of the 44<sup>th</sup> Annual Congress of the Southern Africa Society for Plant Pathology, 22-25 January, Magalies Park Country Club. [paper]
2. **AKJ SURRIDGE, FC WEHMER AND TE CLOETE.** Denaturing Gradient Gel Electrophoresis (DGGE) community analysis of nitrogen fixing bacteria found in petroleum,

- diesel, tar and oil contaminated soil in South Africa. The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9-12 April 2006
3. **DEMOZ, B. & KORSTEN, L.** 2006. Microbial Ecology study of litchi fruit. Litchi Research symposium, Tzaneen. May 2006.
  4. **DU PLESSIS, E.M., LOUW, M.E., BERGER, E. AND THERON, J.** (2006). Evaluation of the *Staphylococcus aureus* acid phosphatase (SAPS) gene as a reporter for gene expression and protein secretion in Gram-negative and Gram-positive bacteria. Fourteenth Biennial Congress of the South African Society for Microbiology, 9-12 April 2006, Pretoria, South Africa.
  5. **GOSZCZYNSKA T, MOLOTO VM, COUTINHO TA,** 2006. Bacterial blight of leek and onion caused by *Pseudomonas syringae*. Proceedings of the 44<sup>th</sup> Annual Congress of the Southern Africa Society for Plant Pathology, 22-25 January, Magalies Park Country Club.
  6. **JOHNSTON, C., JACOBS, R. & KORSTEN, L.** 2006. Development of a PCR rapid identification system for *Penicillium* spp. Litchi Research symposium, Tzaneen. May 2006.
  7. **JR GUMBO AND TE CLOETE.** A flow cytometric technique to assess viability of *Microcystis aeruginosa* cells following bacterial infection. The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9-12 April 2006
  8. **KORSTEN, L.** 2006. Citrus black spot research program at University of Pretoria 2005-2006. 4<sup>th</sup> Citrus Research Symposium, Port Elizabeth 20-23 August 2006. \
  9. **KORSTEN, L.** 2006. Introducing mushroom research at the University of Pretoria. SAMFA Conference 2006, 12-13 July 2006, Kloofzicht Lodge.
  10. **KORSTEN, L. & ZEEMAN, C.A.M.** 2006. Biological control of litchi mould. Litchi Research symposium, Tzaneen. May 2006.
  11. **MALULEKE, M.R., THANTSHA, M.S., CLOETE, T.E. AND KIRKPATRIC, R.** 2006. The antimicrobial mechanism of electrochemically activated water. The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology 9-12 April 2006, CSIR International Convention Centre, Pretoria, SA.
  12. **MEYER, L., JACOBS, R. & KORSTEN, L.** 2006. The practical application of PCR technology in the citrus industry. 4<sup>th</sup> Citrus Research Symposium, Port Elizabeth 20-23 August 2006.
  13. **PAVLIC D, SLIPPERS B, COUTINHO TA, WINGFIELD MJ,** 2006. *Botryosphaeria* spp. from native *Syzygium cordatum* and introduced *Eucalyptus* trees in South Africa. Proceedings of the 44<sup>th</sup> Annual Congress of the Southern Africa Society for Plant Pathology, 22-25 January, Magalies Park Country Club.
  14. **PIETERSEN, G.,** 2006. Progress towards establishment of a comprehensive diagnostic capacity at CRI against citrus graft-transmissible pathogens. 4<sup>th</sup> Citrus Research Symposium, Port Elizabeth, 20-23 August, 2006.
  15. **SCHEEPERS, N.K., JOUBERT, C. & KORSTEN, L.** 2006. Litchi fruit safety and facility hygiene in the export chain. Litchi Research symposium, Tzaneen. May 2006.
  16. **SIVAKUMAR, D. & KORSTEN, L.** 2006. Alternatives to sulphur dioxide treatment for litchi postharvest disease control. Litchi Research symposium, Tzaneen. May 2006.
  17. **THANTSHA, M.S., CLOETE, T.E., MOOLMAN, F.S. and LABUSCHAGNE, P.W.** Survival of microencapsulated cells of probiotic *Bifidobacterium longum* Bb46 cells in simulated gastric and intestinal fluids. The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9-12 April 2006, CSIR International Convention Centre, Pretoria, SA.
  18. **TRUTER, M., KOTZÉ, J.M., MEYER, L., & KORSTEN, L.** 2006. Mysteries of *Guignardia citricarpa* – the switch from green to mean. 4<sup>th</sup> Citrus Research Symposium, Port Elizabeth 20-23 August 2006.
  19. **VAN DER WAALS JE, COUTINHO TA,** 2006. *Erwinia* on potatoes in South Africa: the road ahead. Proceedings of the 44<sup>th</sup> Annual Congress of the Southern Africa Society for Plant Pathology, 22-25 January, Magalies Park Country Club.

20. **VAN GINKEL, C.M., KOTZÉ, J.M., KORSTEN, L. & VAN DER WAALS, J.E.** 2006. Progress on the development of a citrus blackspot disease forecasting model. 4<sup>th</sup> Citrus Research Symposium, Port Elizabeth 20-23 August 2006.
21. **VOSLOO, W., MAREE, F.F., BÖHMER, B., STOREY, P., LEKOANA, T., ESTERHUYSEN, J.J., VAN RENSBURG, H.G., DWARKA, R.M. SAHLE, M., THERON, J., BAXT, B. AND RIEDER, E.** (2006). Reverse genetics provides tools for investigating receptor usage of different topotypes of the SAT types of foot-and-mouth disease virus. Fourteenth Biennial Congress of the South African Society for Microbiology, 9-12 April 2006, Pretoria, South Africa.

## Posters

1. **ADANDONON, A., AVELING, T.A.S., LABUSCHAGNE, N. AND TAMO, M.** Control of Sclerotium-caused cowpea damping-off and stem rot using *Moringa oleifera* extract and biocontrol agents. . 43<sup>rd</sup> Annual Congress of SASPP, Hartenbos, Western Cape, 24-26 January 2006.
2. **BEKKER, T.F., LABUSCHAGNE, N. AND KAISER, C.** Effects of soluble silicon against *Phytophthora cinnamomi* root rot of avocado (*Persea americana* Mill.) nursery plants. South African Avocado Growers Association. Research Symposium, Magoebaskloof, 14 February 2006
3. **BOSHOFF, J., LABUSCHAGNE, N. AND REGNIER, T.** Determining the modes of action of potential biocontrol agents against *Phythium* wilt and root rot of lettuce. . 43<sup>rd</sup> Annual Congress of SASPP, Hartenbos, Western Cape, 24-26 January 2006.
4. **BOTHA A.C., DU PREEZ, M. AND VENTER S.N.** 2006. *Enterococcus* spp. as a microbial tracer to determine the origin of sources of drinking water contamination. Poster presentation at the 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9 - 12 April 2006.
5. **BURGER, L., HUISMANS, H. AND THERON, J.** (2006). Silencing African horsesickness virus VP7 protein expression *in vitro* by RNA interference. Fourteenth Biennial Congress of the South African Society for Microbiology, 9-12 April 2006, Pretoria, South Africa. (Poster)
6. **FOUCHE JP, VILJOEN A, COUTINHO TA,** 2006. Characterisation of *Xanthomonas campestris* pv. *musacearum* causing disease of Ensete and banana in central Africa. Proceedings of the 44<sup>th</sup> Annual Congress of the Southern Africa Society for Plant Pathology, 22-25 January, Magalies Park Country Club.
7. **G ROSS AND TE CLOETE.** The control of cyanobacterial blooms using predatory bacteria and Phoslock. The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9-12 April 2006.
8. **HINZE B, PAVLIC D, COUTINHO TA, WINGFIELD MJ,** 2006. Identification of *Botryosphaeria* spp. occurring on *Schizolobium parahybum* in South Africa. Proceedings of the 44<sup>th</sup> Annual Congress of the Southern Africa Society for Plant Pathology, 22-25 January, Magalies Park Country Club.
9. **KALONJI, J.B., AVELING, T.A.S., LABUSCHAGNE, N. AND VAN DER WAALS J.** Efficacy of fungicides and biological control agents against seedling diseases of lettuce. . 43<sup>rd</sup> Annual Congress of SASPP, Hartenbos, Western Cape, 24-26 January 2006.
10. **KASIER, C., VAN DER MERWE, R., BEKKER, T.F. AND LABUSCHAGNE, N.** In-vitro inhibition of mycelial growth of several phytopathogenic fungi, including *Phytophthora cinnamomi* by soluble silicon. South African Avocado Growers Association. Research Symposium, Magoebaskloof, 14 February 2006.
11. **MAMABOLO, M.E. HORN, C.H., CLOETE, T.E., THANTSHA, M.S. AND MARÉ, L.** Growth optimization of *L. Salivanus* 241 as a potential animal probiotic. The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9-12 April 2006.



12. **MD SAID, SN VENTER AND TE CLOETE.** The Role of the natural and socio-economic factors in maintaining *Vibrio cholerae* in the environment: The case of epidemic cholera in KwaZulu-Natal. The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9-12 April 2006.
13. **MEYER, J.B., PIETERSEN, G., NEL, L.H., and KASDORF, G.G.F.,** 2006. Evaluation of the efficiency of four mealybug species to transmit activated-episomal Banana streak badnavirus. Proceedings of the 44<sup>rd</sup> Congress of the South African Society for Plant Pathology. Magalies Park Country Club 22-25 January, 2006.
14. **NDOU, P.M., REGNIER, T., HALUEENDO, L., ZEEMAN, K. & KORSTEN, L.** 2006. Mode of action of a new antagonist for the control of *Guignardia* spp, *Colletotrichum gloeosporioides* and *Penicillium digitatum*. 4<sup>th</sup> Citrus Research Symposium, Port Elizabeth 20-23 August 2006.
15. **PJ WILLIAMS, H GEYER, AKJ SURRIDGE, J KATABUA AND TE CLOETE.** Bacterial population study of the industrial wastewater and iron ore of the Sishen Iron Ore Mine. The 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9-12 April 2006.
16. **PRETORIUS, J.M., BRÖZEL, V.S. AND THERON, J.** (2006). Characterisation of *Bacillus cereus* biofilm-impaired transposon mutants. Fourteenth Biennial Congress of the South African Society for Microbiology, 9-12 April 2006, Pretoria, South Africa. (Poster)
17. **RAMUSI, T.M., AVELING, T., VAN DER WAALS, J. AND LABUSCHAGNE, N.** Biological and fungicidal control of seedling diseases of cowpea caused by *Fusarium solani*, *Pythium* species and *Rhizoctonia solani*. 43<sup>rd</sup> Annual Congress of SASPP, Hartenbos, Western Cape, 24-26 January 2006.
18. **REGNIER, T., NDOU, P.M., ZEEMAN, K., TRUTER, M. & KORSTEN, L.** Selective medium for *Guignardia citricarpa*, the causal agent of citrus black spot. 4<sup>th</sup> Citrus Research Symposium, Port Elizabeth 20-23 August 2006.
19. **ROOS, H.J., HUISMANS, H. AND THERON, J.** (2006). Silencing of the nonstructural gene NS1 of African horsesickness virus by RNA interference. Fourteenth Biennial Congress of the South African Society for Microbiology, 9-12 April 2006, Pretoria, South Africa. (Poster)
20. **SAID, M.D., CLOETE T.E. AND VENTER, S.N.** 2006. The role of the natural and socio-economic factors in maintaining *Vibrio cholerae* in the environment: The case of epidemic cholera in KwaZulu-Natal. Poster presentation at the 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9 - 12 April 2006.
21. **STEWART, K. and PIETERSEN, G.,** 2006. Development and implementation of PCR and microarray-based methods to differentiate citrus tristeza virus (CTV) strains. 4<sup>th</sup> Citrus Research Symposium, Port Elizabeth, 20-23 August, 2006.
22. **STEWART, K., and PIETERSEN, G.,** 2006. Dynamics and molecular characterisation of citrus tristeza virus (CTV) strains within South African GFMS12 cross-protecting population. Proceedings of the 44<sup>rd</sup> Congress of the South African Society for Plant Pathology. Magalies Park Country Club 22-25 January, 2006.
23. **SWART L, BRADY CL, GREYLING I, VENTER SN, COUTINHO TA,** 2006. Phylogenetic relationship between *Pantoea* spp. and the bacteria causing blight and die-back of *Eucalyptus*. Proceedings of the 44<sup>th</sup> Annual Congress of the Southern Africa Society for Plant Pathology, 22-25 January, Magalies Park Country Club.
24. **SWART L, BRADY CL, VENTER SN, COUTINHO TA,** 2006. *Pantoea* spp. associated with bacterial blight and die-back of *Eucalyptus*. Proceedings of the 14<sup>th</sup> Biennial Congress of the South Africa Society for Microbiology, 9-12 April, CSIR International Convention Centre, Pretoria.
25. **VAN BLERK, G.N., MATSHUSA, P., GREBEN, H. AND VENTER, S.N.** 2006. Molecular analysis of microbial communities in sulphate removing bioreactors using terminal restriction fragment length polymorphism (t-RFLP). Poster presentation at the 14<sup>th</sup> Biennial Congress of the South African Society for Microbiology, 9 - 12 April 2006.
26. **VAN DER MERWE, J.J. & VAN DER WAALS, J.E.** 2006. Optimisation of inoculation techniques for *Pectobacterium* spp. (*Erwinia*) on potatoes. 44<sup>th</sup> Annual Congress of the

- Southern African Society for Plant Pathology. Magalies Park, South Africa.*
27. **VAN DER WAALS, J.E. & COUTINHO, T.** 2006. *Erwinia* on potatoes in SA: The road ahead. 44<sup>th</sup> Annual Congress of the Southern African Society for Plant Pathology. Magalies Park, South Africa.

## INTERNATIONAL CONFERENCE CONTRIBUTIONS

### Invited speaker

1. **T.E. CLOETE.** The use of biotechnology in the water industry. IWA World Conference, Beijing, China, September 2006.
2. **T.E.CLOETE.** Biotechnology frontiers in the 21<sup>st</sup> Century. 27<sup>th</sup> African Health Sciences Congress, 3-7 December 2007, Durban, South Africa.
3. **COUTINHO TA, GOSZCZYNSKA T, DE MAAYER P, VENTER SN,** 2006. *Pantoea ananatis*: an emerging pathogen? In: Proceedings of the 11<sup>th</sup> International Congress on Plant Pathogenic Bacteria, 10-14<sup>th</sup> July, Edinburgh, Scotland, United Kingdom: pp. 64-65. (invited paper).
4. **KORSTEN, L.** 2006. Review on biological control of pre- and postharvest diseases in mango. 8<sup>th</sup> International Mango Symposium. Sun City, 6-9 February 2006.
5. **MEYER, L. & KORSTEN, L.** 2006. (Invited paper) A PCR technique to detect *Mycogone perniciosa* causing wet bubble disease on button mushrooms. Australian Mushroom Growers Association P&D Diagnostic Workshop and Industry Conference, Adelaide, Australia, 1-7 October 2006.
6. **VENTER, S.N.** 2006. Infection control: The role of water. The 7<sup>th</sup> Congress of the International Federation of Infection Control, Stellenbosch, South Africa, 3 - 5 July 2006

### Papers

1. **BRADY CL, VENTER SN, CLEENWERCK I, VANCANNEYT M, SWINGS J, COUTINHO TA,** 2006. Examining the taxonomy of the genus *Pantoea*. In: Proceedings of the 11<sup>th</sup> International Congress on Plant Pathogenic Bacteria, 10-14<sup>th</sup> July, Edinburgh, Scotland, United Kingdom: pp. 23-24.
2. **CLOETE, T.E. AND GUMBO, J.R.** (University of Pretoria, RSA) "A flow cytometric technique to assess viable and membrane compromised cells of *Microcystis aeruginosa* upon predation by a biological control agent: *Bacillus mycoides*". International Conference and Exhibition on Water in the Environment. 20.-22. February 2006, Stellenbosch, South Africa.
3. **CLOETE, T.E. AND ROSS, G.** (University of Pretoria, RSA) "The control of cyanobacterial blooms using predatory bacteria and Phoslock". International Conference and Exhibition on Water in the Environment. 20.-22. February 2006, Stellenbosch, South Africa.
4. **COETZEE, P.** 2006. Molecular phylogeny of canine rabies in Kwazulu Natal. 8<sup>th</sup> Southern and Eastern African Rabies Group Meeting, Windhoek, Namibia. 22-26 January 2006.
5. **KORSTEN, L., HAVENGA, W. & ZEEMAN, K.** 2006. Mode of action of *Bacillus subtilis* as biocontrol agent of avocado postharvest diseases. International Organisation for Biological and Integrated Control of Noxious Animals and Plants (IOBC), Spa, Brussels, 6-10 September 2006.

6. **MARKOTTER, W.** Molecular epidemiology and characterization of Lagos bat virus isolates from South Africa, 8 th Meeting of the Southern and Eastern African Rabies Group (SEARG), Heja Game Lodge, Windhoek, Namibia, 22- 26 January 2006.
7. **MARKOTTER, W.**, Classical rabies diagnostics and new developments, 8 th Meeting of the Southern and Eastern African Rabies Group (SEARG), Heja Game Lodge, Windhoek, Namibia, 22- 26 January 2006.
8. **MEYER, L. & KORSTEN, L.** 2006. Detection of *Mycogone pernicioso* causing wet bubble disease on button mushrooms. Australian Mushroom Growers Association P&D Diagnostic Workshop and Industry Conference, Adelaide, Australia, 1-7 October 2006.
9. **MOOLMAN, F.S., LABUSCHAGNE, P.W., THANTSHA, M.S., VAN DER MERWE, T.L., ROLFES, H. AND CLOETE, T.E.** "A novel encapsulation method for probiotics using interpolymer complex in supercritical carbon dioxide. XIV International workshop on bibencapsulation and cost 865 Meeting, Lausanne, Switzerland, 5-7 October 2006.
10. **N. VAN ZYL.** 2006. RABNET: The value of a global network for rabies. 8th Southern and Eastern African Rabies Group Meeting, Windhoek, Namibia. 22-26 January 2006.
11. **NEL, L.H.** 2006. Non-rabies lyssaviruses from Africa: the status quo. 8th Southern and Eastern African Rabies Group Meeting, Windhoek, Namibia. 22-26 January 2006.
12. **NEL, L.H. RANGLES, J., PAWESKA, J.T., MARKOTTER, W., COETZEE, P. AND SABETA, CT.** 2006. Recent epidemiology of southern african lyssaviruses. The XVII International Conference Rabies in the Americas. Brasília, Brazil. October 15-20, 2006
13. **PHALATSI, N.** 2006. DNA vaccines for rabies: An Overview. 8th Southern and Eastern African Rabies Group Meeting, Windhoek, Namibia. 22-26 January 2006.
14. **PIETERSEN, G.**, 2006. Spatio-temporal distribution dynamics of grapevine leafroll disease in Western Cape vineyards. Pg. 126-127. Extended abstracts of the 15<sup>th</sup> Meeting of the International Council for the Study of Virus and Virus-like diseases of the Grapevine (ICVG) 3-7 April, Stellenbosch, South Africa.
15. **PIETERSEN, G.**, 2006. Use of remote sensing to monitor the spread of grapevine leafroll disease in South Africa. Pg. 122-123. Extended abstracts of the 15<sup>th</sup> Meeting of the International Council for the Study of Virus and Virus-like diseases of the Grapevine (ICVG) 3-7 April, Stellenbosch, South Africa.
16. **SACCAGI, D.L., KRÜGER,K., and PIETERSEN, G.**, 2006. Rapid identification of three mealybug species by multiplex PCR. Pg. 124-125. Extended abstracts of the 15<sup>th</sup> Meeting of the International Council for the Study of Virus and Virus-like diseases of the Grapevine (ICVG) 3-7 April, Stellenbosch, South Africa.
17. **SAID, M.D., CLOETE, T.E. AND VENTER, S.N.** 2006. The 2000-2002 Cholera epidemic in KwaZulu-Natal: A possible link between population demographics, water and sanitation, International Water Association, Young Professional Congress, Singapore, May 2006.
18. **SPREETH, N.A., OOSTHUIZEN, W.T., VAN RENSBURG, A., TOOTH, D., ROSSOUW, N., and PIETERSEN, G.**, 2006. Vergelegen, South Africa; a case study of an integrated control strategy to prevent the spread of grapevine leafroll disease. Pg. 142-143. Extended abstracts of the 15<sup>th</sup> Meeting of the International Council for the Study of Virus and Virus-like diseases of the Grapevine (ICVG) 3-7 April, Stellenbosch, South Africa.
19. **SWART L, BRADY CL, VENTER SN, COUTINHO TA,** 2006. Phylogenetic relationship between *Pantoea* spp. and the bacteria causing blight and die-back of *Eucalyptus*. Workshop on *Erwinia* spp., 6- 9 July, Dundee, Scotland, United Kingdom.
20. **VENTER, S. N., BOOYSEN, I., CLOETE, T.E. AND SAID, M.D.** (University of Pretoria, RSA) "Health aspects of the water sources in the environment: The 2000/04 cholera epidemic In KwaZulu-Natal, South Africa" International Conference and Exhibition on Water in the Environment. 20.-22. February 2006, Stellenbosch, South Africa.
21. **VERMEULEN, H., JORDAAN, D., KORSTEN, L. & KIRSTEN, J.** 2006. Private standards, handling and hygiene in fruit export supply chains: A preliminary evaluation of the economic impact of parallel standards. 26th conference of the International Association of Agricultural Economists (IAAE), Queensland, Australia, 12-18 August 2006.

22. **WEYER, J.** 2006. Rabies vaccination: Future trends. 8th Southern and Eastern African Rabies Group Meeting, Windhoek, Namibia. 22-26 January 2006.

## Posters

1. **BLIGNAUT, B., MAREE, F.F., THERON, J., RIEDER, E. AND VOSLOO, W.** (2006). Important growth determinants for genetically engineered SAT type foot-and-mouth disease viruses. EUROPIC 2006 XIV Meeting of the European Study Group on the Molecular Biology of Picornaviruses, 26 November -1 December 2006, Saariselkä, Finland.
2. **BURGER, L., HUISMANS, H. AND THERON, J.** (2006). Silencing African Horsesickness virus VP7 protein expression *in vitro* by RNA interference. 9th International Symposium on dsRNA Viruses, 22 - 27 October 2006, Cape Town, South Africa.
3. **DE MAAYER P, VENTER SN, COUTINHO TA,** 2006. The virulence factors of *Pantoea ananatis*. In: Proceedings of the 11<sup>th</sup> International Congress on Plant Pathogenic Bacteria, 10-14<sup>th</sup> July, Edinburgh, Scotland, United Kingdom: pp/ 143
4. **FOURIE, G., STEENKAMP, E., GORDON, T.R. AND VILJOEN, A.** 2006. A multigene phylogeny determines the genetic relatedness among the lineages of the polymorphic fungus *Fusarium oxysporum* f.sp. *ubense*. European Fusarium Seminar, Wageningen, The Netherlands, 19-22 September 2006
5. **KIGGUNDU, A., KUNERT, K., VILJOEN, A., MICHAUD, D.** 2006. Engineering plant cysteine proteinase inhibitors for the transgenic control of the banana weevil (*Cosmopolitus sordidus*) and other coleopteran insect pests. Tropical Crops Biotechnology Conference, Cairns, Australia.
6. **MAREE, F.F., BLIGNAUT, B., VOSLOO, W., THERON, J. AND RIEDER, E.** (2006). Selection of variants utilising heparin sulphate for cell entry when South African Territories foot and mouth disease virus is adapted for growth on cell culture. EUROPIC 2006 XIV Meeting of the European Study Group on the Molecular Biology of Picornaviruses, 26 November -1 December 2006, Saariselkä, Finland.
7. **MEYER, J.B., ROBINSON, J.C., PIETERSEN, G AND NEL, L.H.** 2006. Transmission studies of activated-episomal banana streak badnavirus from FHIA-21 (AAAB) by four mealybug species. XVII Acorbat International Meeting, 15-20 October, Joinville, Brazil.
8. **MEYER, T., DONZELLI, B.G.G., CHURCHILL, A.C.L. AND VILJOEN, A.** 2006. Development of an Agrobacterium tumefaciens-mediated transformation system for gene disruption in *Fusarium oxysporum* f.sp. *ubense*. European Fusarium Seminar, Wageningen, The Netherlands, 19-22 September 2006.
9. **MUNRO, C., VAN DEN BERG, N., MYBURG, A.A. AND VILJOEN, A.** 2006. Identification of defense-related genes in banana against Fusarium wilt. European Fusarium Seminar, Wageningen, The Netherlands, 19-22 September 2006.
10. **OBERHOLSTER, P.J., BOTHA, A.M. AND CLOETE, T.E.** 2006. Toxic cyanobacterial blooms in a shallow artificially mixed urban lake Colorado. USA. Conference, Alaska, April 2006
11. **OBERHOLSTER,P.J., BOTHA, A.-M. and CLOETE, T.E.** 2006. Use of molecular as indicators for winter zooplankton grazing on toxic benthic cyanobacteria colonies in an urban Colorado lake, April 2006
12. **ROSS, G. and T.E. CLOETE.** The use of Phoslock for the control of eutrophication. IWA World Conference, Beijing, September 2006.
13. **VAN DEN BERG, N., HINZE, I., BIRCH, P., BERGER, D., WINGFIELD, M.J. AND VILJOEN, A.** 2006. Genes up-regulated in a tolerant Cavendish banana in response to *Fusarium oxysporum* f.sp. *ubense* infection. European Fusarium Seminar, Wageningen, The Netherlands, 19-22 September 2006.
14. **VAN DER WAALS, J.E., VAN DER MERWE, J.J.** 2006. Optimisation of inoculation techniques for *Pectobacterium* spp. on potatoes. *International Erwinia Workshop*. Scottish



- Crops Research Institute, Dundee, Scotland, UK.
15. **VAN DER WAALS, J.E., VAN DER WAALS, J.H. & VAN DER MERWE, J.J.** 2006. The effect of silicon on *Pectobacterium* infection of potatoes. *11<sup>th</sup> International Conference on Plant Pathogenic Bacteria*. Edinburgh, Scotland, UK.
  16. **VLJOEN, A., NEL, B., BELGROVE, A. AND STEINBERG, C.** Managing Fusarium wilt of banana by means of systemic acquired (SAR) and induced systemic resistance (ISR). European Fusarium Seminar, Wageningen, The Netherlands, 19-22 September 2006.

## **MSc AND PhD DEGREES AWARDED**

### **MSc – MICROBIOLOGY**

#### **D.J.F. DU PLESSIS:**

Transcriptional activity of the *rhIAB* genes of *Pseudomonas aeruginosa* PAO1 during biofilm development. (*cum laude*)

Supervisor: Prof J. Theron

Co-supervisor: Prof V.S. Brözel

#### **L. BURGER:**

Silencing African horse sickness virus VP7 protein expression *in vitro* by RNA interference. (*cum laude*)

Supervisor: Prof J. Theron

Co-supervisor: Prof H. Huisman

#### **M.J. SORRILL:**

Molecular cloning and expression of the 3ABC nonstructural protein-coding region from a SAT2 foot-and-mouth disease virus.

Supervisor: Prof J Theron

Co-supervisor: Dr H.G. van Rensburg

#### **A. SWANEPOEL:**

Transcriptional analysis and mutagenesis of the *htp* fimbrial gene cluster from *Pseudomonas aeruginosa* PAO1. (*cum laude*)

Supervisor: Prof J Theron

#### **R. MALULEKE:**

Biofilm monitoring and control using electrochemically activated water and chlorine dioxide.

Supervisor: Prof T E Cloete

#### **C. PHASHA:**

Health and Safety Aspects of the operation of urine diversion toilets.

Supervisor: Prof T E Cloete



**J. MAVHUNGU:**

Isolation and characterization of Lactic Acid bacteria from “Ting” in the Northern Province of South Africa.

Supervisor: Prof T E Cloete

**P. RANDIMA:**

The development of Rhizoremediation as a treatment technology for the removal of PAH's on the environment.

Supervisor: Prof T E Cloete

**L. M. BURKE:**

Fate of *Salmonella* Typhimurium in biofilms of drinking water distribution systems.

Supervisor: Prof S. N. Venter

Co-supervisor: Prof V. S. Brözel

**J. LE ROUX:**

Population dynamics of *Vibrio cholerae* in the Vaal Barrage catchment

Supervisor: Prof S.N. Venter

**J. B. MEYER:**

Banana streak badnavirus (BSV) in South Africa: incidence, transmission and the development of an antibody based detection system.

Supervisor: Prof L H Nel

Co-supervisor: Prof G Pietersen

**O. KOCH:**

Towards the diagnosis of two intracellular pathogens of grapevine in South Africa.

Supervisor: Prof G Pietersen

Co-supervisor: Prof L H Nel

**P. COETZEE:**

Molecular epidemiology of rabies in KwaZulu-Natal, South Africa

Supervisor: Prof L H Nel

**MSc – PLANT PATHOLOGY****S. GROENEWALD:**

Biology, pathogenicity and diversity of *Fusarium oxysporum* f.sp. *cubense*

Supervisor: A. Viljoen

Co-supervisors: N. van den Berg, W.F.O. Marasas

**R. SUTHERLAND:**

Genetic modification of Cavendish bananas (*Musa* spp.) in South Africa.

Supervisor: A. Viljoen

Co-supervisors: J.V. Escalant, K.Kunert, R. Chikwamba

**L. STRONKHORST:**

The effect of soil chemical properties and plant nutrition on the growth of banana (*Musa acuminata* L.A. Colla) plants infected with Fusarium wilt

Supervisor: J. van der Waals

Co-supervisors: A. Viljoen, A. Claasens

**J. BOSHOFF:**

**Biological control of Pythium wilt and root rot in hydroponically grown lettuce**

Supervisor: Prof N Labuschagne

Co-supervisor: Prof L Korsten

**PhD – Microbiology**

**B. STEYN:**

Proteomic analysis of the biofilm and biofilm-associated phenotypes of *Pseudomonas aeruginosa* cultured in batch.

Supervisor: Prof J. Theron

Co-supervisor: Prof V.S. Brözel

**P. OBERHOLSTER**

Monitoring ecology and biomonitoring of total petroleum contaminated soil environment.

Supervisor: Prof T E Cloete

**R. DUBE**

Appropriate positioning of modeling as a decision support tool for surface water resources planning in South Africa.

Supervisor: Prof T E Cloete

**M. SAID:**

Epidemic cholera in KwaZulu-Natal: The Role of the Natural and Social Environment.

Supervisor: Prof T E Cloete

Co-supervisor: Prof S.N. Venter

**J. WEYER:**

Immune responses against recombinant poxvirus vaccines that express full length lyssavirus glycoprotein genes.

Supervisor: Prof L H Nel

**MSC AGRIC: PLANT PATHOLOGY:**

**W KEESENBERG:**

Food safety and quality throughout the apple export chain

Supervisor: Prof L Korsten

**MINSTAGRAR (PLANT PATHOLOGY)**

**I TSHIVANDEKANO:**

Water quality in Gauteng contributing to food safety risk in Agriculture.

Supervisor: Prof L Korsten

Co-supervisor: Prof M Taylor

**PhD – PLANT PATHOLOGY**

**N. VAN DEN BERG**

Identification of genes associated with tolerance in the Cavendish banana selection GCTCV-218, against *Fusarium oxysporum* f.sp. *cubense* “subtropical” race 4.

Supervisor: A. Viljoen

Co-supervisors: D.K. Berger, P.R.J. Birch, M.J. Wingfield

**J. DE GRAAF**

Integrated pest management of the banana weevil, *Cosmopolitus sordidus* (Germar) in South Africa

Supervisor: P. Govender

Co-supervisors: A. Viljoen, A. Schoeman

**G. W. DU PLOOY:**

Aspects of mango (*Mangifera indica* L.) fruit rind morphology and chemistry and their implications for post harvest quality.

Supervisor: Prof L Korsten

**S. Y. ATHMAN:**

Host-endophyte-pest interactions of endophytic *Fusarium oxysporum* antagonistic to *Radopholus similis* in banana (*Musa* spp).

Promotor : Prof N Labuschagne

Co-promotor : Dr A Viljoen

**PhD: Environmental Management:****I. PAUL:**

Mapping and distribution of citrus greening in South Africa.

Supervisor: Prof A van Jaarsveld

Co-supervisor: Prof L Korsten